



GM-713/719 COLOR MONITOR

MANUAL



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MANUAL

Part No. 504229D

**RAMTEK CORPORATION
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Santa Clara, California 95050**



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1. SPECIFICATIONS

1.1 GENERAL DESCRIPTION

- A. Rack Mountable EIA Standard
- B. Drawer Structure - Almost all adjustment controls are in a drawer and are made to be easily accessible.
- C. Multi-Frequency Range - This model will be locked at any horizontal frequency within the range of 15 KHz to 18 KHz without readjustments except for convergence.
- D. Unique Dynamic Convergence Circuit--Extremely Stable Performance and Easy Maintenance - R.G.B. trio controls are provided for each adjustment point of dynamic convergence. Beam movements by each R.G.B. trio is exactly the same as that by static convergence magnets.

Each R.G.B. trio adjusts beam movements independently without influencing one another and they can be adjusted as easy as static convergence.

Readjustment is not required for more than 2000 hours after once properly adjusted.

- E. Adoption of Dynamic Focus - Uniformed best focus can be achieved because of Dynamic Focus Circuit.
 - 1. For Higher Reliability:
 - a. All solid state except for CRT
 - b. Complete seal type of power transformer
 - c. Spark killer circuit
 - 2. For Better Stability:
 - a. Adoption of video amplifier with feedback clamp type of DC restoration circuit for stability of white balance for a long period of time.

- b. Built in high stable HV regulator circuit for minimum charge of raster height against changes of average picture level (APL).
 - c. Built in high stable power regulator circuit for minimum charge in picture quality against line voltage changes.
 - d. Built in regulator circuit for all bias voltage to CRT (including heater) for stable white balance.
 - e. Automatic Brightness Limiter Circuit for longer life of CRT and prevention of overload with HV circuits.
3. For Ease of Service:
- a. Each PCB is easily replaceable without a soldering iron.
 - b. Checks on main PCBs can be done and they can be replaced while the unit is in a rack.
 - c. Health checker indicates when a fault occurs with any main circuit.
4. For Various Applications:
- a. Power input: AC 100V, 110V, 120V, 220V, 240V, 50/60 Hz
 - b. Built in sync switch for separate sync (negative going) on PCB Video.
 - c. Two video input connectors per R.G.B. (loop through) are provided for simultaneous operation of multiple monitors.

1.2 POWER REQUIREMENTS

- A. Input Power: AC 100V, 110V, 120V, 220V, 240V, $\pm 10\%$; 50/60 Hz
- B. Power Consumption: Less than 250VA
- C. Video Signal Input: R.G.B. 0.3 V to 2.0 VP-P (Negative going sync)
- D. Separate Sync Signal Input: Sync Signal 1 VP-P to 5 VP-P (Negative)
- E. Video Input Impedance: High Impedance or 75 ohm termination plus loop through



- F. Sync Input Impedance: High impedance or 75 ohm termination plus loop through
- G. Termination Operation: Switch controlled
- H. Video Output: More than 40 VP-P
- I. Scanning Frequency: Horizontal --- 15 KHz - 18 KHz
Vertical --- 50 Hz - 60 Hz
- J. CRT: 3 gun, shadow mask, burst protection type, electric magnetic deflection static focus.
- K. Maximum Effective Screen Size: GM-713: 10.6" (W) x 7.9" (H) nominal
GM-719: 15.6" (W) x 11.7" (H) nominal
- L. Ambient Temperature: -5C -- 40C

1.3 CONFIGURATION

- A. External Dimension: See Drawing
- B. Weight: Approximately 100 lbs (with cabinet)
- C. Appearance: See Drawing

1.4 CIRCUIT CHARACTERISTICS

- A. Video Amplifier Frequency Response: 50 Hz -- 15 MHz ± 3 dB
- B. Pulse Characteristics Rise and Fall Time: Less than 40 nS

C. Video Amplifier Differential Gain: Less than 5%

D. Horizontal Blanking Time: GM-713: Less than 9 μ sec

GM-719: Less than 8 μ sec

Vertical Blanking Time: Less than 0.6 msec

E. Linearity: Less than $\pm 7\%$ Calculation formula

$$\frac{\text{MAX} - \text{MIN}}{\text{MEAN}} \times 1/2 \times 100 (5)$$

F. Raster Distortion: Less than 2%

G. Convergence: Less than 0.5 mm in a centrally located area bounded by a circle. The diameter of this circle is equal to picture height. Elsewhere less than 1.0 mm.

H. Raster Regulation: Less than 1% change in size (0% to 100% APL)

I. Black Level Stability: Less than 1% of peak luminance within the range of 10% to 90% APL.

J. HV Regulation: Less than 1% of nominal at anode current 0 - 500 A.

1.5 CONTROLS

A. Front Controls

1. Brightness
2. Health light
3. Power-on/off switch
4. Degauss switch
5. Color/monochrome selection switch

B. Controls in Drawer

1. V-Height
2. V-Linearity
3. V-Hold
4. H-Width
5. H-Hold
6. Gain (Contrast)
7. Red beam on/off switch
8. Green beam on/off switch
9. Blue beam on/off switch
10. Red background controls
11. Green background controls
12. Blue background controls
13. Red contrast
14. Green contrast
15. Blue contrast
16. Dynamic Focus
17. 30 convergence controls
18. Underscan/normal switch
19. Underscan/width control
20. Underscan/height control

C. Side Controls

1. Focus
2. Internal/external sync switch

D. Measured X-Radiation Level

Product complies with DHEW Rules 21 and CFR Subchapter J, applicable at date of manufacture.

2. ALIGNMENT PROCEDURE

2.1 PREPARATION

Set the connector at the AC power input to correspond with the available line voltage. Set the Sync Selector switch, S451, on the VIDEO board for WITH SYNC if a composite video signal is to be used, and WITHOUT SYNC if a separate sync input is to be used. When using composite video input signals, the sync is applied via the green input channel.

2.2 TURN-ON AND DEGAUSS

The display monitor should be warmed-up for one hour and degaussed before adjustment procedures are initiated. The CRT is degaussed by a built-in degaussing coil. The front panel DEGAUSS switch is held "on" for at least five seconds during which time the initial strong ac field decays to a minimum value prior to release of the switch. If held in the "on" position only momentarily, and then released, the strong field may actually magnetize the CRT with subsequent degradation of performance. The degaussing circuit must cool down before the switch is pressed again. This will permit a strong ac field to be initiated when first held in the ON position. Other parts of the monitor must be degaussed by a manually held degaussing coil which is moved slowly around chassis components. This coil should be at least six feet from the monitor when it is switched on or off.

2.3 ALIGNMENT NOTES

Re-adjustment of low and high voltage power supplies may necessitate a complete re-alignment of the monitor because all circuits may be affected. DC voltages measuring within 3 or 4 percent of the indicated value should not be changed unless a complete alignment is planned. (Assume a DC meter with a basic accuracy of $\pm 3\%$ was used during the previous alignment.) Power supply adjustments should be made with a DC meter having 1% accuracy, if available. Marginal operation of regulated voltage supplies can best be determined by swinging the line voltage $\pm 10\%$ while monitoring each voltage.

Convergence adjustments are usually performed after completion of dc, high voltage, focus, heighth, width and pincushion adjustments have been completed, as any of these may affect convergence. For this reason, it is recommended that unnecessary adjustments should not be performed. Gray scale tracking adjustments will not affect convergence, but it is usually convenient to perform such adjustments before doing convergence. Once a CRT monitor has been completely aligned, it is unlikely that any of the adjustments will drift substantially. If inspection shows excessive changes in any of the parameters, suspect circuit failure, incorrect line voltage, or (far out) the monitor has been misadjusted.

Color contamination in display images of an otherwise normally operating monitor are usually due to unwanted magnetic fields. When degaussing, remember chassis components may be the source of such fields.

Convergence problems found after shipment of a monitor may be caused by jarring of the equipment during transit. Suspect that static convergence has slipped because such adjustments are performed by the mechanical positioning of permanent magnets around the neck of the CRT. Dynamic convergence is electrical and less likely to be affected by jarring.

Best convergence is obtained with the monitor mounted in its normal operating position, or with the axis of the CRT aligned identically to that of its normal position. If unknown, align the axis of the CRT with magnetic north to minimize the maximum amount of distortion possible due to earth's magnetic field. (The face plate of the CRT is perpendicular to the axis of the CRT.)

2.4 DC POWER SUPPLY ADJUSTMENTS

Low side probe to chassis. Do not adjust if voltages are within $\pm 3\%$. Use 1% dc meter for adjustments.

VOLTAGE	TEST POINT	VARIABLE RESISTOR	OTHER CHECKS
+130Vdc	TP91	VR931	Regulation
+100Vdc	TP92	VR932	Regulation
+60Vdc	TP93	VR933	Regulation

2.5 HIGH VOLTAGE SUPPLY ADJUSTMENT

Low side probe to chassis. Turn instrument OFF when connecting or disconnecting probe. Use electrostatic meter or VTVM with high voltage multiplier probe.

WARNING

- X-rays are emitted at 25Kv. They may be hazardous to your health.
- Contact with the high voltage can result in serious injury or death.

VOLTAGE	CHECK POINT	VARIABLE RESISTOR	OTHER CHECKS
24Kv	Anode cap on CRT	VR301	Display image should not change size (bloom) as BRIGHTNESS control is rotated over its full range.

2.6 FOCUS

Both static and dynamic FOCUS controls must be adjusted. The static adjustment sets the dc voltage level; the dynamic adjustment controls the amount of sweep modulation superimposed on the dc voltage. This permits optimizing focus over the viewing area of the CRT. The two adjustments interact and both adjustments should be repeated to obtain the best overall focus.

PC BOARD	TYPE OF ADJUSTMENT	VARIABLE RESISTOR	COMMENT
High Voltage	Voltage Adjustment	VR591	Check for best focus over center portion of CRT screen.
Control	Dynamic (modulating waveform)	VR501	Adjust for best overall focus. Repeat adjustments of VR591 and VR501.

2.7 RASTER SIZE AND CENTERING ADJUSTMENTS

Horizontal and vertical adjustments must be performed with a display image locked onto the CRT screen.

2.8 HORIZONTAL WIDTH, CENTERING

ADJUSTMENT	VARIABLE RESISTOR	COMMENT
Horizontal Centering	VR503	Center image horizontally. Range of VR503 is controlled by the position of switch S501.
Horizontal Width	VR971	Adjust for proper width. Recenter, if necessary.

2.9 HEIGHT, VERTICAL LINEARITY AND CENTERING ADJUSTMENTS

Height and vertical linearity adjustments will interact. After symmetry is achieved, the vertical centering control should be used to recenter the image. Proceed as follows:

- a. Move switch S971 on CONTROL board to the side where the displayed image is largest.
- b. Adjust BRIGHTNESS control for a suitable display.
- c. Adjust HEIGHT control, VR401, on PCB-CONTROL for vertical size.
- d. Adjust LINEARITY control, VR403, for linear spacing of horizontal lines from the bottom to the top of display. This control will interact with the HEIGHT control which may have to be re-adjusted.
- e. If necessary, re-center the displayed image vertically with VR404. The range of VR404 is controlled by switch S401.

2.10 UNDERSCAN ADJUSTMENT

Switch S971 of the previous paragraph should now be moved to the opposite end of its slide. Note that the displayed image is reduced in size. Adjust HEIGHT control VR402 (not the same control as used in the previous paragraph), and WIDTH control, VR972, to the point where all four corners are visible. Leave Switch S971 in its present position.

2.11 PINCUSHION ADJUSTMENTS

Set the input signal from the crosshatch generator for both vertical and horizontal lines. Proceed as follows:

- a. Adjust VR703, if necessary, to set the horizontal line at the center of the display as straight as possible. This control interacts with VR704 which may have to be re-adjusted before VR703 will have sufficient range.
- b. Adjust the top and bottom pincushion control, VR702, for straight vertical lines at each side of the display.
- c. Adjust VR704 for a straight horizontal line at the top of the screen.
- d. Controls VR702 and VR704 also interact. Controls VR702, VR703, and VR704 may require further touch-up to obtain the best results. Repeat steps a, b, and c, if necessary.

- e. Adjust VR701 for straight vertical lines at the right and left sides of the displayed image.

2.12 CRT SCREEN AND FOCUS ADJUSTMENTS

CRT screen voltage adjustments are critical to gray scale renditions. The adjustments are performed with a low level brightness display to mix the outputs of the three guns in the CRT in the proper proportions. The CRT screen should display black, grays, and whites without color contamination over the full range of the BRIGHTNESS control.

- a. Set the BRIGHTNESS control for a low level (dim) display image.
- b. If the image is not gray, adjust screen controls VR174, VR175, and VR176 until color contamination is removed. Vary one at a time while noting the effect on the CRT screen. Return each variable resistor to its original setting, if the desired result is not obtained.
- c. If unable to obtain a low level gray display, use the following procedure to obtain a coarse adjustment which can be refined as outlined in step b.
 - 1) Set CONTRAST controls VR171A, VR172A, and VR173A fully counterclockwise.
 - 2) Set GAIN controls VR174, VR175, and VR176 fully counterclockwise.
 - 3) Set BRIGHTNESS control VR691 fully counterclockwise.
 - 4) Using a high impedance meter, set voltages at terminals 4, 5, and 13 to 500 Vdc. The controls are located in the pull-out drawer at the front of the monitor. Controls relate to electron guns as follows:

GUN	TERMINAL	CONTROL
Blue	13	VR391
Green	5	VR392
Red	4	VR393

- 5) Slowly return BRIGHTNESS control to the point where a displayed image is just visible.
- 6) Small final adjustments of VR391, VR392, or VR393 should result in a low level gray display.
- 7) Re-check focus adjustments.

2.13 VIDEO AMPLIFIER ADJUSTMENTS

CRT monitors with serial 9101300 and below have a 15 MHz video bandwidth. Serials 9101301 and higher have a 25 MHz bandwidth. The later version video amplifiers are backwards compatible to the earlier series. However, an early amplifier with 15 MHz bandwidth should not be installed in one of the higher serial numbered monitors. The following procedures define the alignment of each type of amplifier.

A composite signal source such as crosshatch generator and a sweep generator should be used as signal sources in the following procedures. Adjust vertical and horizontal HOLD controls as necessary to lock in a display image.

2.14 PEDESTAL LEVEL ADJUSTMENT

The pedestal level sets the blanking level of the CRT which prevents visible retrace lines during the period when the sweeps are returning to the beginning of each scan.

Set the crosshatch generator for an output voltage of 1 Vp-p at the Green input of the CRT monitor. Set CONTRACT and GAIN controls to the middle of their range. Adjust CLAMP LEVEL ADJ (VR271) on the video board to obtain 100 volts ± 1 V p-p measured at terminal 6 on the CRT socket board. An oscilloscope must be used for this measurement.

2.15 FREQUENCY RESPONSE

Frequency response adjustments require a sweep generator capable of sweeping the range of 50 Hz to 25 MHz in monitors with serial numbers 9101301 and above. (Sweep range is 50 Hz to 15 MHz in monitors with serial numbers 9101300 and below.)

Adjust the applied signal to 1 volt p-p at the input of the green channel. Adjust CONTRAST and GAIN controls of the green channel to obtain an output voltage of 40 volts p-p at a frequency of less than 500 kHz. The measurement point is at the green output terminal of the video board. Connect the oscilloscope via a 1 pF capacitor and a 10:1 oscilloscope probe to terminal 6 on the CRT board.

Adjust inductors L201 and L202 to set variations in the response curve within -3dB over the range of one mHz to 25mHz in the case of serial numbered monitors having serial numbers 9101301 and higher, and +1 to -3dB over the range of 1 mHz to 15 mHz in the case of serial numbered monitors having serial numbers below 9101301.

Perform the same adjustments for the blue and red channels. Terminal 11 of the CRT board is the blue channel output; terminal 2 is the output of the red channel.

2.16 AUTOMATIC BEAM LIMITER (ABL) Adjustment

Adjust the input voltage to one volt p-p at the input of the green channel. Connect a VTVM between TP1 on the high voltage (HV) board. Turn BRIGHTNESS, CONTRAST, and GAIN controls fully counterclockwise (for monitors with serials 9101301 and higher). Adjust VR601 on the video board to obtain a reading of -12 ± 0.5 Vdc. Monitors having serial numbers below 9101301 should be setup the same as noted for monitors having higher serial numbers except that the BRIGHTNESS control should be set fully clockwise. Adjust VR601 to obtain a reading of -13.2 ± 0.5 volts on the VTVM.

2.17 VIDEO PHASE ADJUSTMENT

Lock in a suitable display image on the CRT. Adjust BRIGHTNESS for a dim raster. Adjust variable resistor VR502 to center the image.

2.18 COLOR ADJUSTMENTS

Prior to color adjustments, the monitor is prepared by setting vertical, horizontal, yoke (for tilted picture), centering, and high voltages as detailed in the preceding alignment procedures. If these adjustments have not been done correctly, you will probably not be able to properly set-up the monitor for color. Once you complete color adjustments, do not re-do any of those adjustments mentioned as you may have to re-do the color adjustments.

Adjustments of focus, horizontal, vertical, high voltage, and degaussing procedures must be completed before starting color adjustments. Color adjustments can be broken down into four categories:

- Purity
- Gray Scale Tracking
- Static Convergence
- Dynamic Convergence

Purity, static convergence, and dynamic convergence have a cumulative effect of deflection of the electron beams and therefore interact with each other to some degree. This necessitates re-checking adjustments to ensure that refinements to previous adjustments will be performed when required. Without these refinements, satisfactory convergence may not be achieved. Gray scale tracking does not interact with purity or convergence adjustments. This is important because it means that gray scale tracking adjustments can be made at any time without requiring a complete re-convergence. However, this is not true of the pre-requisite adjustments to the horizontal, vertical sweeps, high voltage, etc. They will affect convergence.

2.19 DEGAUSSING

Degauss the CRT at turn-on and allow a full hour for warm-up of the monitor. At the end of the warm-up period, re-check that the high voltage with the BRIGHTNESS control are set for a low-level brightness pattern on the screen. Remember, the high voltage affects convergence directly, and also that voltage in excess of 24kV can cause X-ray radiation hazardous to the technician and viewers (through the face plate of the CRT). Brightness is set to a low level to reduce beam current, the load on the high voltage supply. This should ensure the high voltage limit is not exceeded. If degaussing is not complete, an external degaussing coil should be used.

2.20 PURITY ADJUSTMENTS

Purity adjustments depend on the positioning of two ring magnets at the rear of the CRT neck. All three colors must be checked for purity, one at a time. The red gun is adjusted first. If proper purity is achieved, the blue and green guns will probably be ok. If not, a very minor refinement to the purity magnets will probably clear up the contamination.

Check purity by switching OFF the green and blue screens. (Switches are in pull-out drawer.) The screen should then be an even red in color. Lighter red areas may indicate purity adjustments are required. If lighter areas are noticed, degauss the CRT and chassis and recheck purity before proceeding.

- a. Minor positioning of two tabs on purity magnet will normally correct the problem. If unable to correct purity by positioning the tabs, loosen the deflection yoke and slide the yoke towards the rear of the chassis. Notice that the red area is centered on the CRT. If it is not centered, move the tabs on the purity magnet individually to center the red area. Move the yoke back to its original position. Be careful not to tilt the yoke as this will tilt the displayed image. The CRT should now display an even red color over the full viewing surface.

- b. Switch the green screen to ON and the red screen to OFF. The screen should be an even green color. Switch the blue screen to ON and the green screen to OFF. The screen should be an even blue color. Switch the green and red screen switches to ON.

2.21 GRAY SCALE TRACKING

Gray scale tracking provides for changing from high brightness levels of the pattern to a dull gray without changes in color. It does not interact with color convergence. A white at high brightness with a color shift at low brightness indicates the screen controls are set incorrectly. If not white at high levels but ok at low brightness levels, suspect the video drive or the external signal.

2.22 STATIC CONVERGENCE

Static convergence consists of adjusting four permanent magnets to focus the electron beam from the three guns to an assigned one of the three color dots in a cluster at the center of the CRT screen. Use a scale/ruler to locate this dot cluster and circle it with a grease pencil. The procedure requires the three color dots to be separated and then brought together again with the greatest possible accuracy. A 20 to 40 power magnifying glass is very useful when doing convergence. Proceed as follows:

- a. Separate the red and green dots by turning the red and green static convergence magnets. The screen should now show the three dots of the center cluster. Turn off the blue gun with the blue screen switch. Dots should be separated by approximately $\frac{1}{4}$ inch. Bring the dots together by adjusting the magnets on the yoke. Check with a magnifying glass to verify a single yellow dot results. There should not be any fringing (other color contamination).
- b. Switch ON the blue screen. Move the blue dot to merge with the yellow dot. The magnet moves the blue dot only in a vertical direction. If

offset horizontally from the yellow dot, it can be moved sideways with the blue lateral magnet. Two types of blue lateral magnets are used in GM-713/GM-719 Graphic Monitors. The conventional permanent magnet type is moved with a thumbwheel knob located on top of the blue static magnet. The knob is located on the underside of the CRT neck directly across from the blue static magnet on some versions. A second type of blue lateral magnet found on some models uses an electromagnet instead of the permanent magnet. The dynamic range of this type of blue lateral magnet is coarsely selected by moving a connector. Once the coarse adjustment is selected, an amplitude and symmetry adjustment must be performed. The adjustment procedure for the dynamic blue lateral magnet follows:

- 1) On convergence board, variable resistor VR801 sets amplitude (gain).
- 2) On the same board, variable resistor VR802 is adjusted for best symmetry.
- 3) Check blue raster with red and green screen switches OFF. Compare the raster width with that raster width obtained with red and green switches ON, and blue screen switch OFF. Adjust the blue raster width with inductors L8A1 and L8A2 mounted on the small 2 inch by 2 inch board at the top left of the monitor (above the deflection board).

NOTE

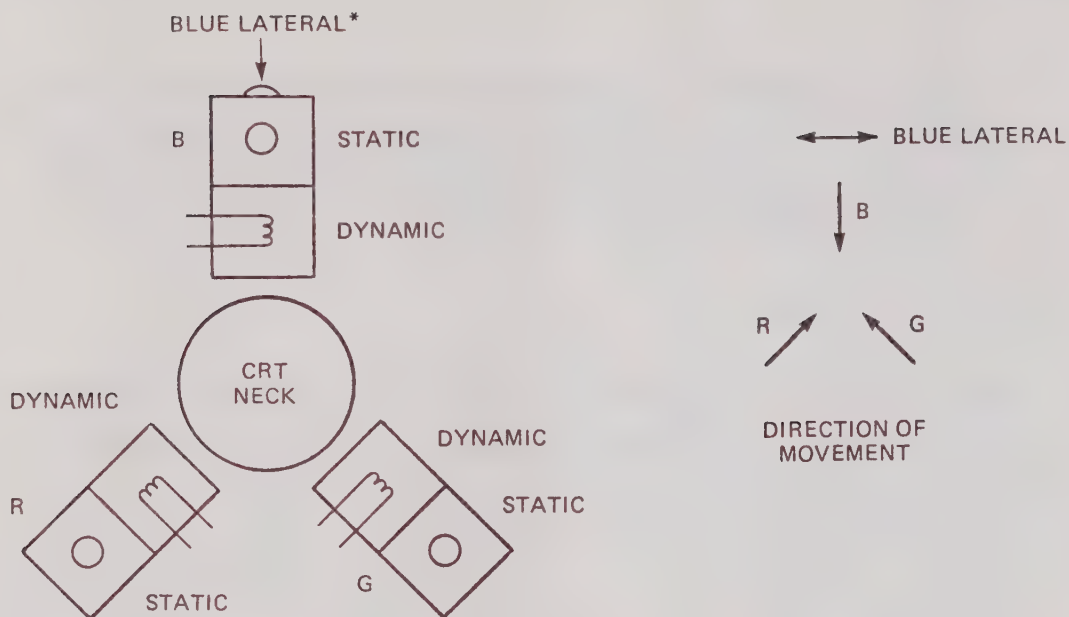
- The blue raster is widened with the connector in the YA position on the small board, and connector MJ is in the MJ2 position; narrowed by moving it to the MJ1 position. When connector YA is in the OFF position, MJ1 and MJ2 are out of the circuit.

Static convergence is completed when the selected dot trio at the center of the CRT is perfectly converged with no color fringing. The effect of subsequent dynamic convergence adjustments may require minor refinement of the static convergence adjustments.

2.23 DYNAMIC CONVERGENCE

Dynamic convergence is controlled by three electromagnets located on the convergence yoke in the same plane as the static convergence magnets. A varying current developed from the horizontal and vertical sweep circuits is adjustable to permit slight bending of the electron beams from the three guns. The magnetic fields from the static magnets and the electromagnets are additive. Thus, the combined magnetic field created by the magnets will vary depending on what portion of the screen is being swept by the beam of electrons. Since the convergence yoke and deflection yoke current are derived from the same source, it is obvious they are synchronized. Different sets of controls are provided so that different parts of the screen can have individual correcting magnetic fields. Proceed as follows:

- Set the input signal from the crosshatch generator to the crosshatch pattern. Figure 2-1 shows the sequence of adjustments, the location of three gain adjustments for red, green, and blue guns, and (by position on the figure) the area of the CRT affected by the controls. Adjust only those areas that require convergence, beginning at the lowest numbered area.



* Blue lateral may be directly beneath the CRT instead of above. It performs the same in either location.

PCB-CONV (IN DRAWER)

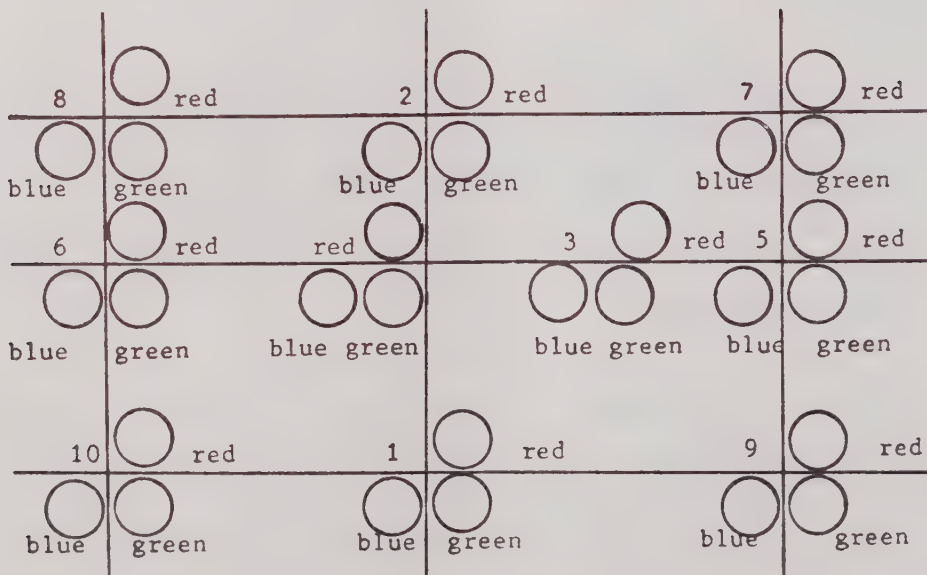


Figure 2-1. Convergence Magnets and Adjustments

2.24 REFERENCE DRAWINGS

A. Figure 2-2	Front and Rear Panels
B. Figure 2-3	Convergence PCB
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D. Figure 2-5	Power PCB
E. Figure 2-6	Power-REG PCB
F. Figure 2-7	Video PCB
G. Figure 2-8	Video PCB
H. Figure 2-9	Deflection PCB
I. Figure 2-10	Deflection PCB
J. Figure 2-11	D-BL PCB
K. Figure 2-12	Connector PCB
L. Figure 2-13	High Voltage PCB
M. Figure 2-14	CRT PCB

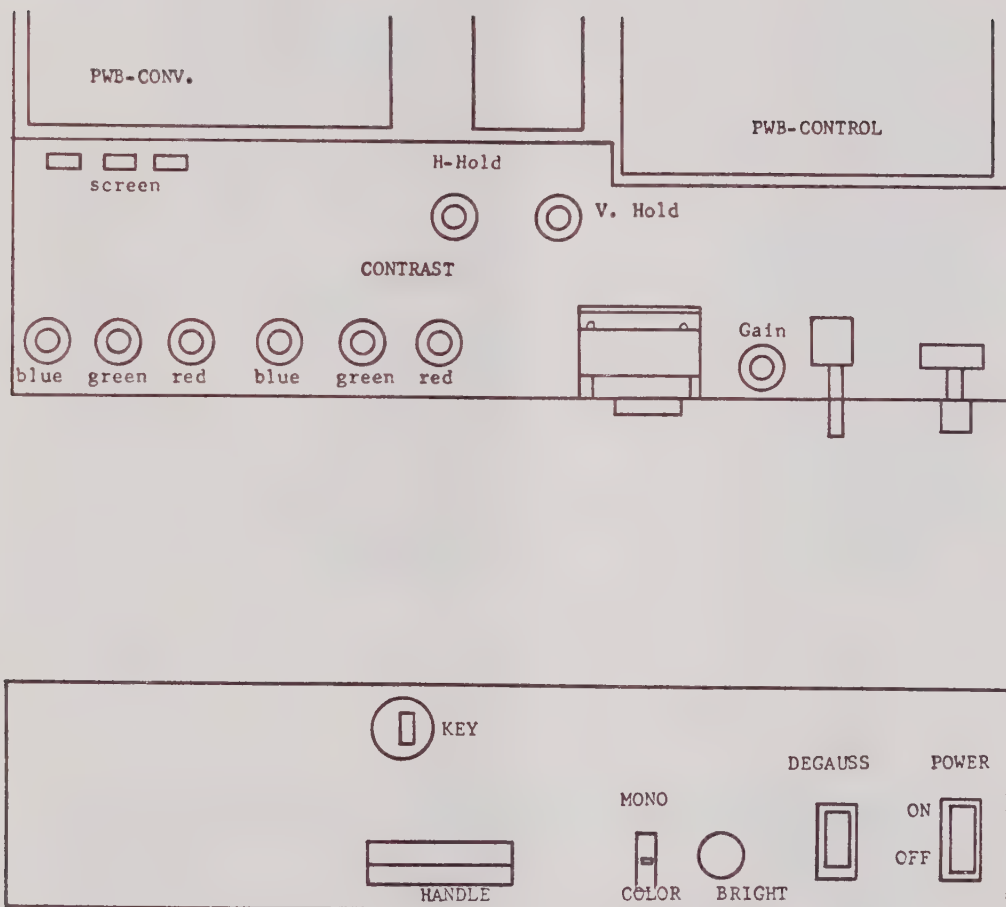


FIGURE 2-2. Front and Rear Panels

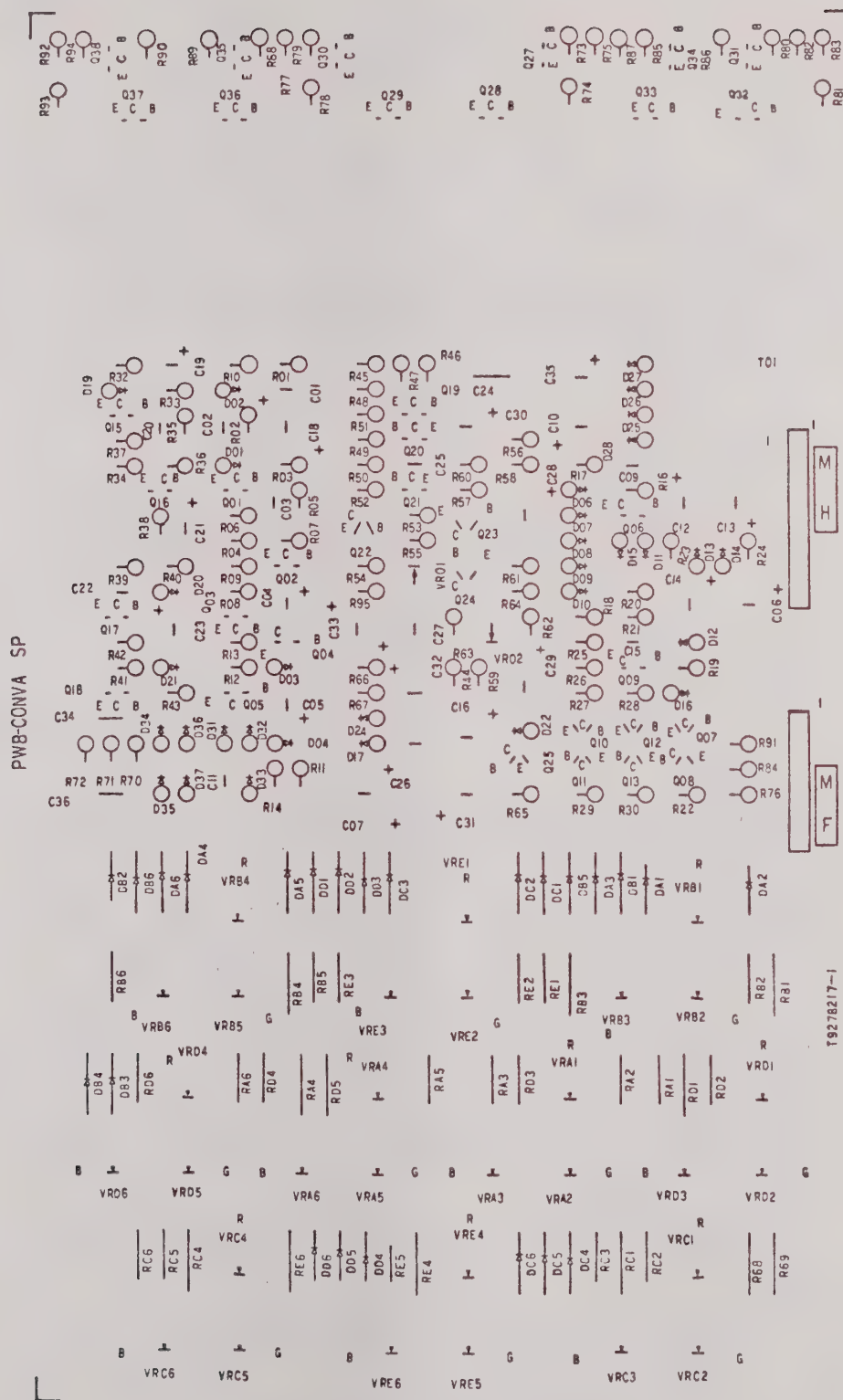


FIGURE 2-3. Convergence PCB



2-18

PWB-POWERA SP

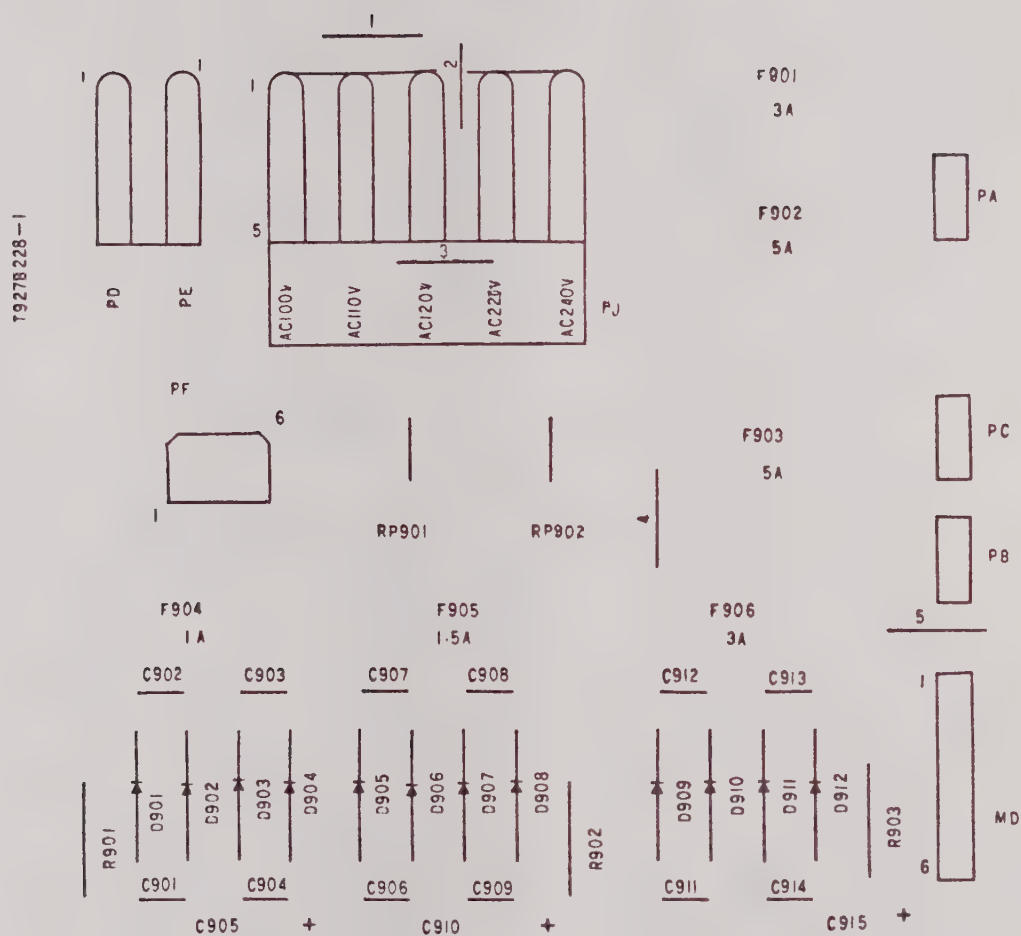


FIGURE 2-5. Power PCB

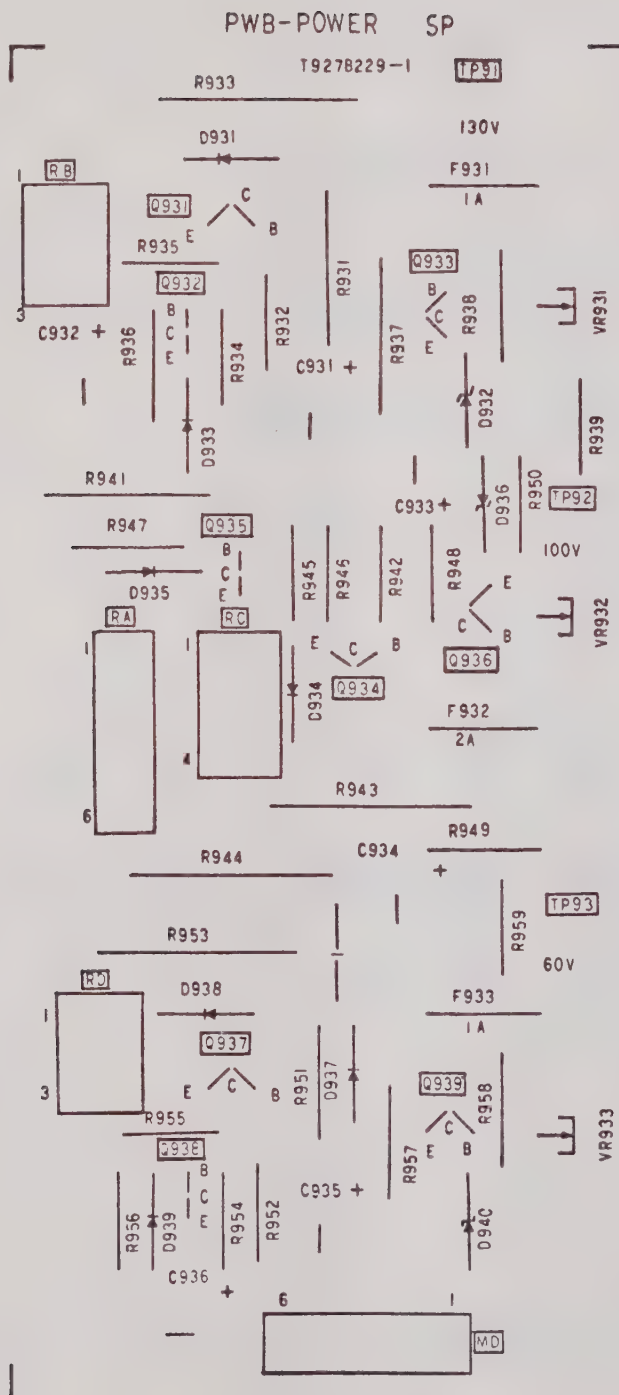


FIGURE 2-6. Power-REG PCB

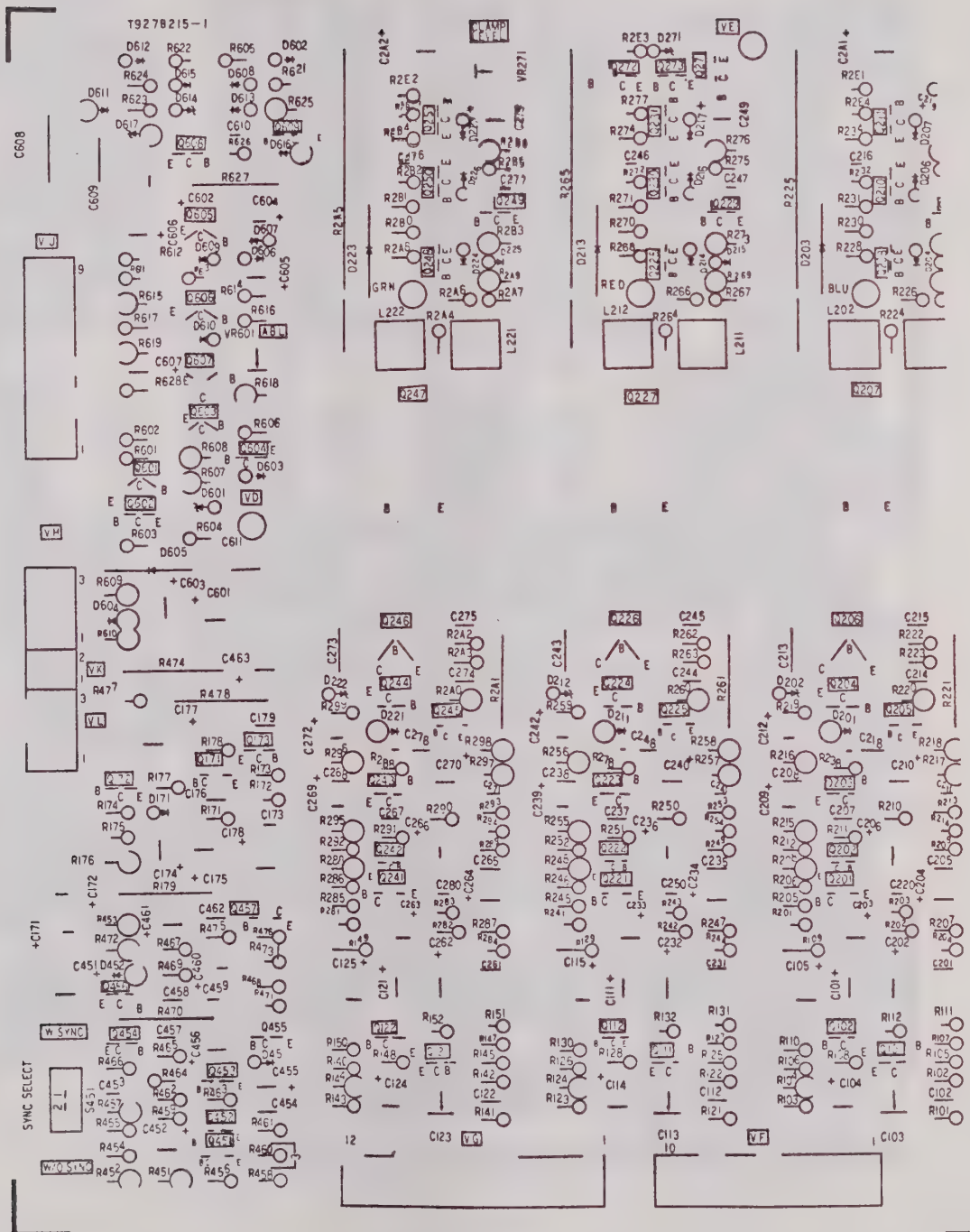


FIGURE 2-7. Video PCB

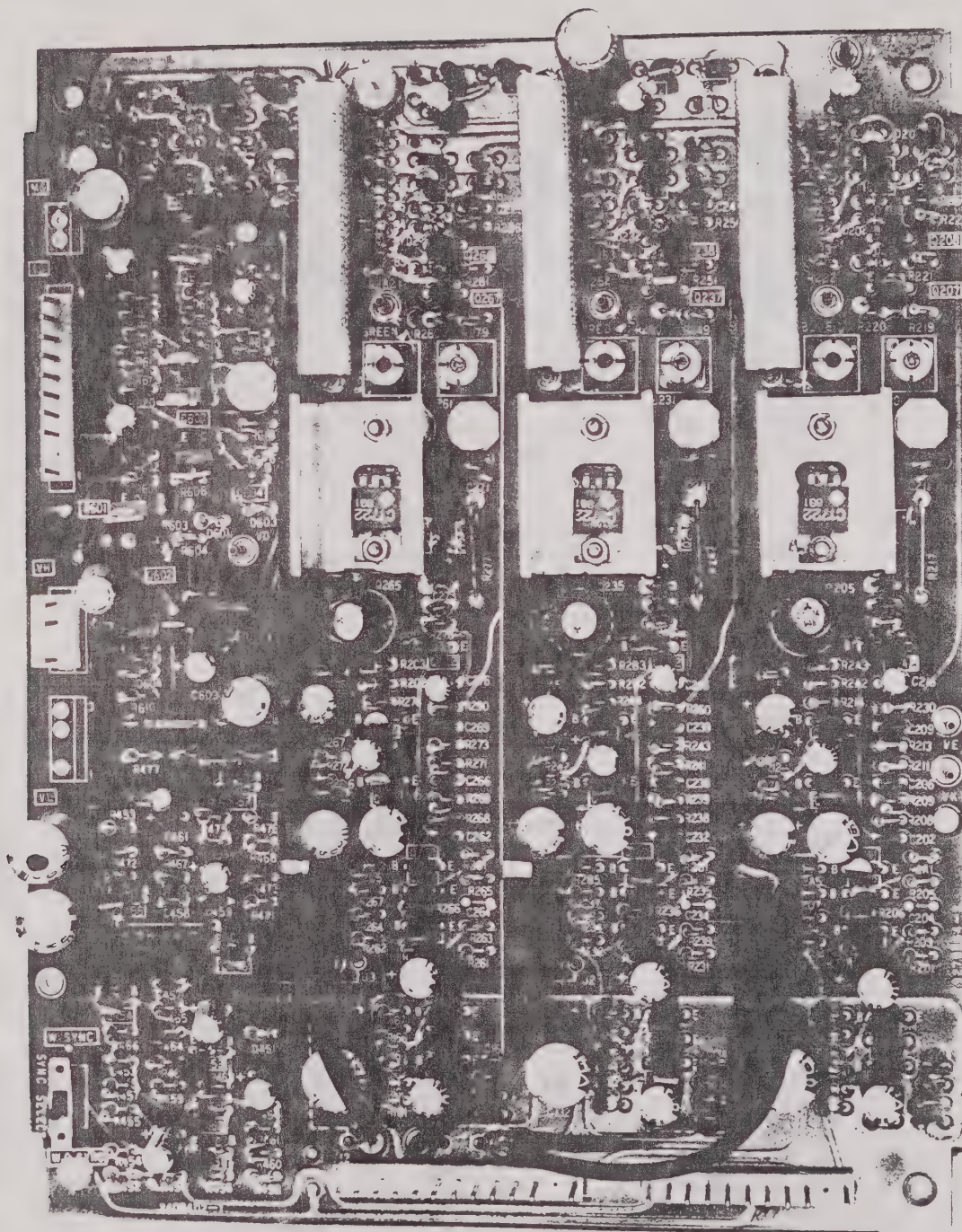


FIGURE 2-8. Video PCB

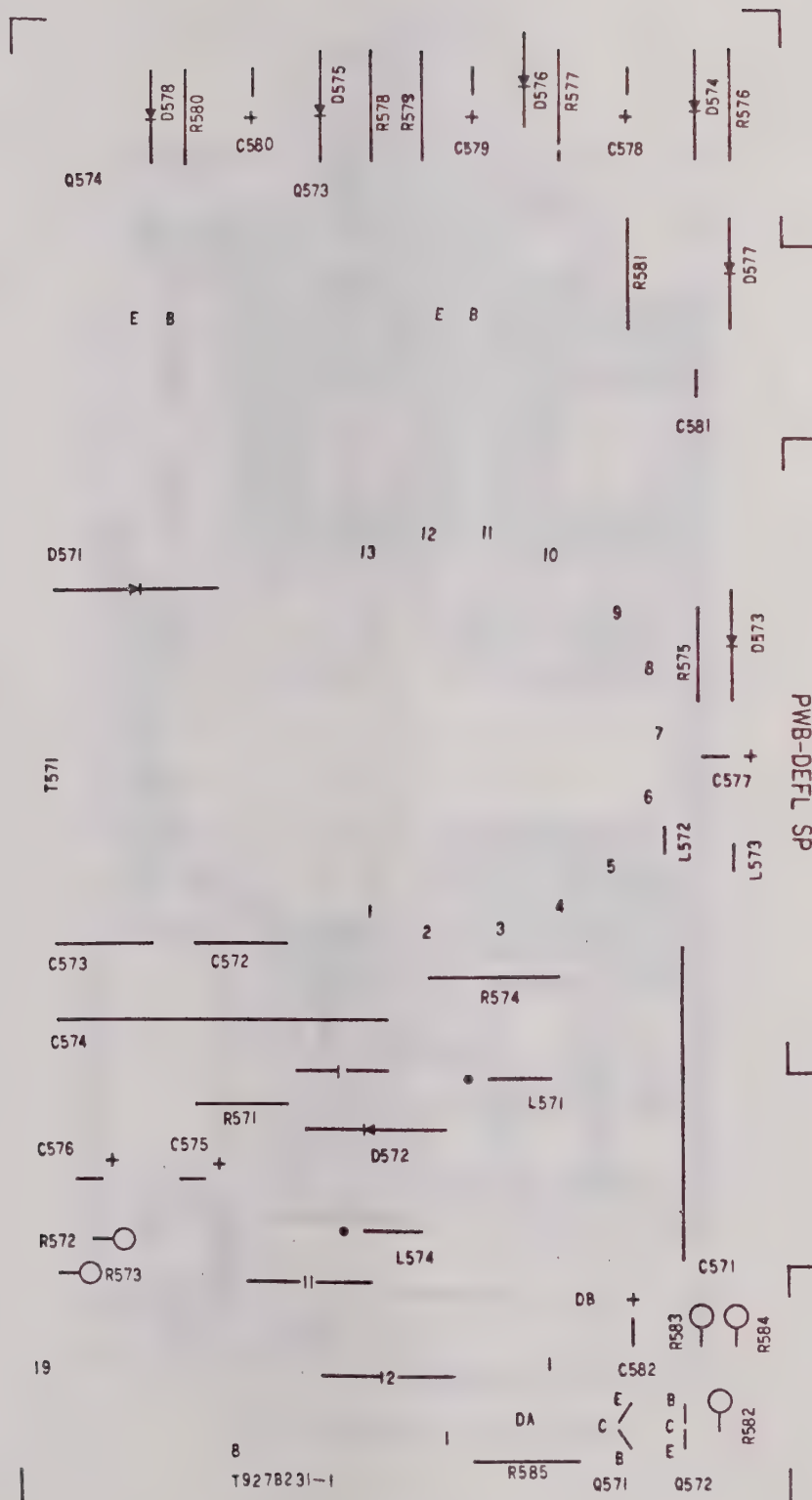


FIGURE 2-9. Deflection PCB

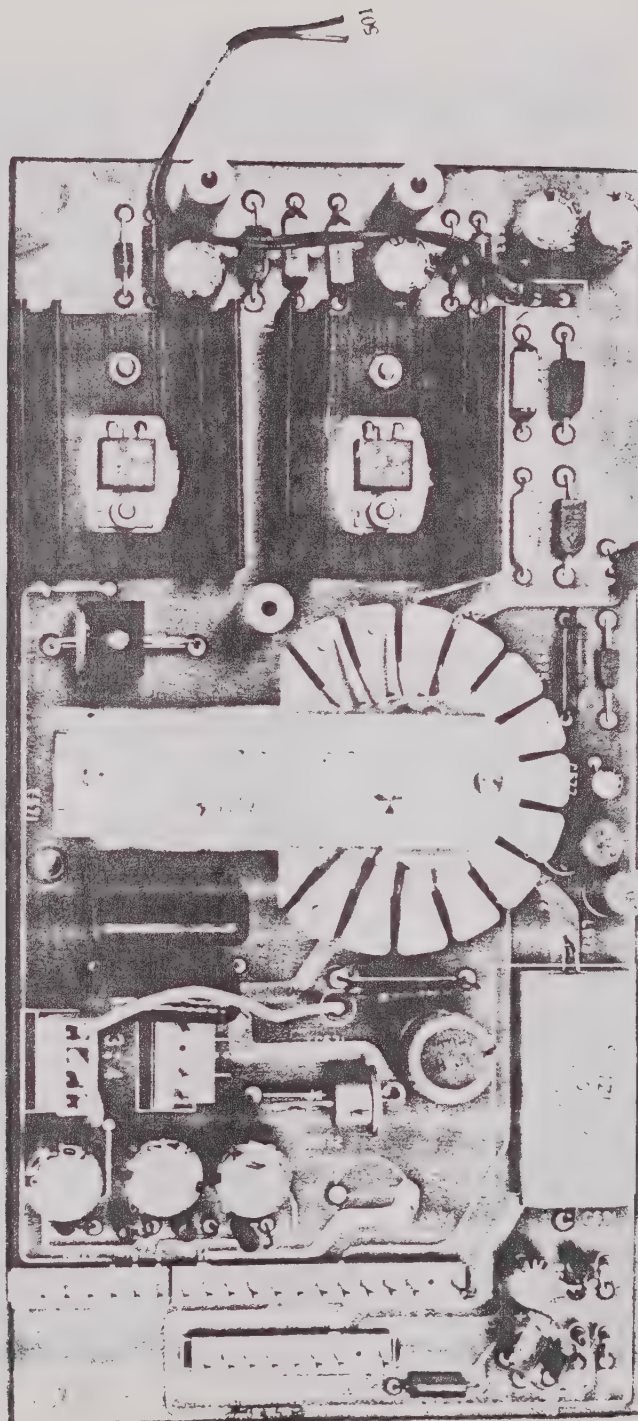


FIGURE 2-10. Deflection PCB

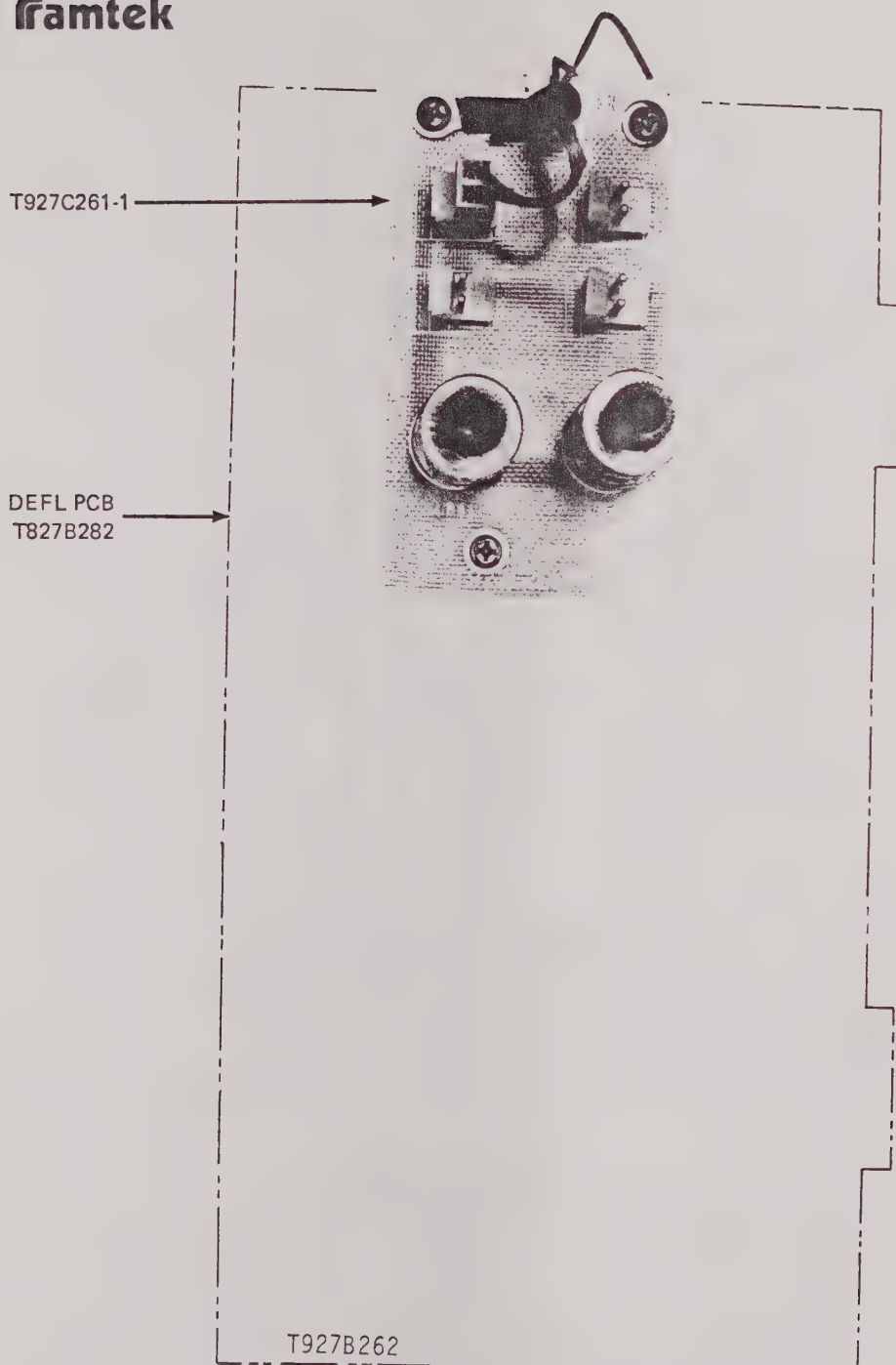


FIGURE 2-11. D-BL PCB

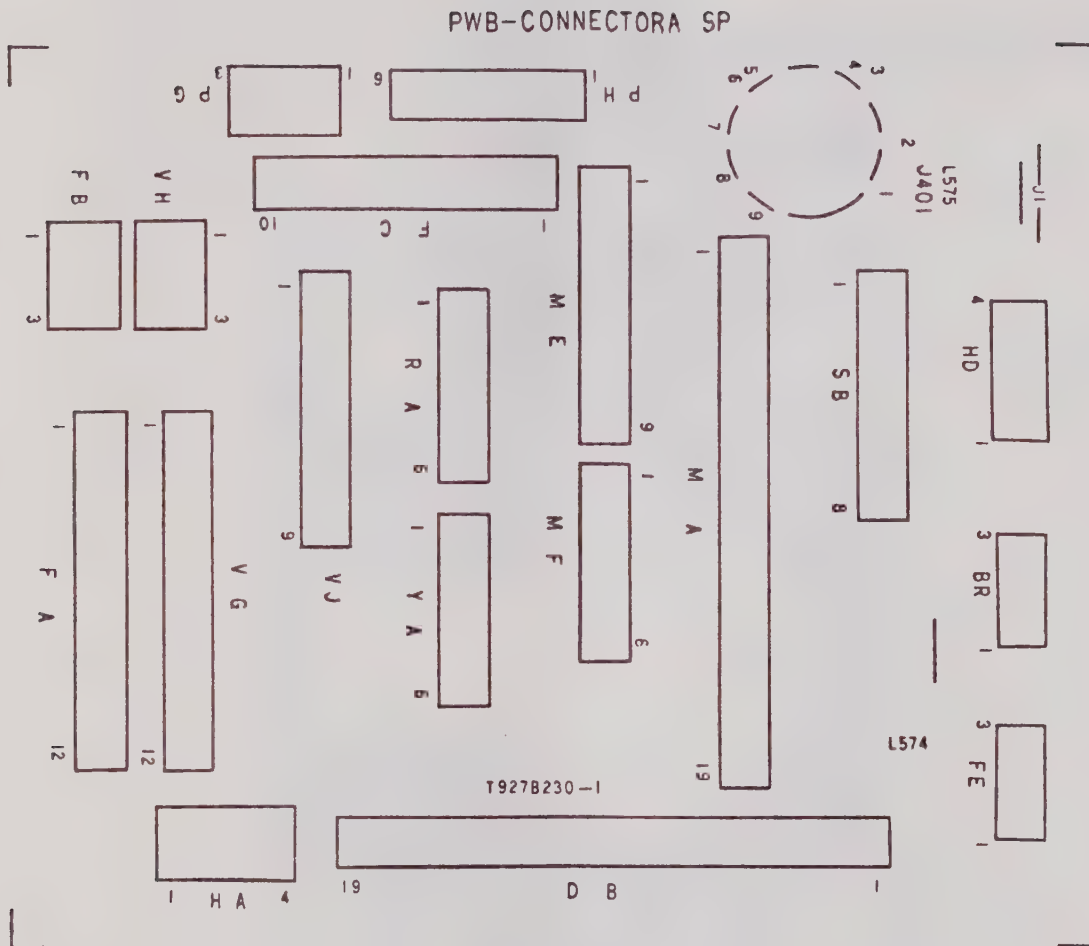


FIGURE 2-12. Connector PCB

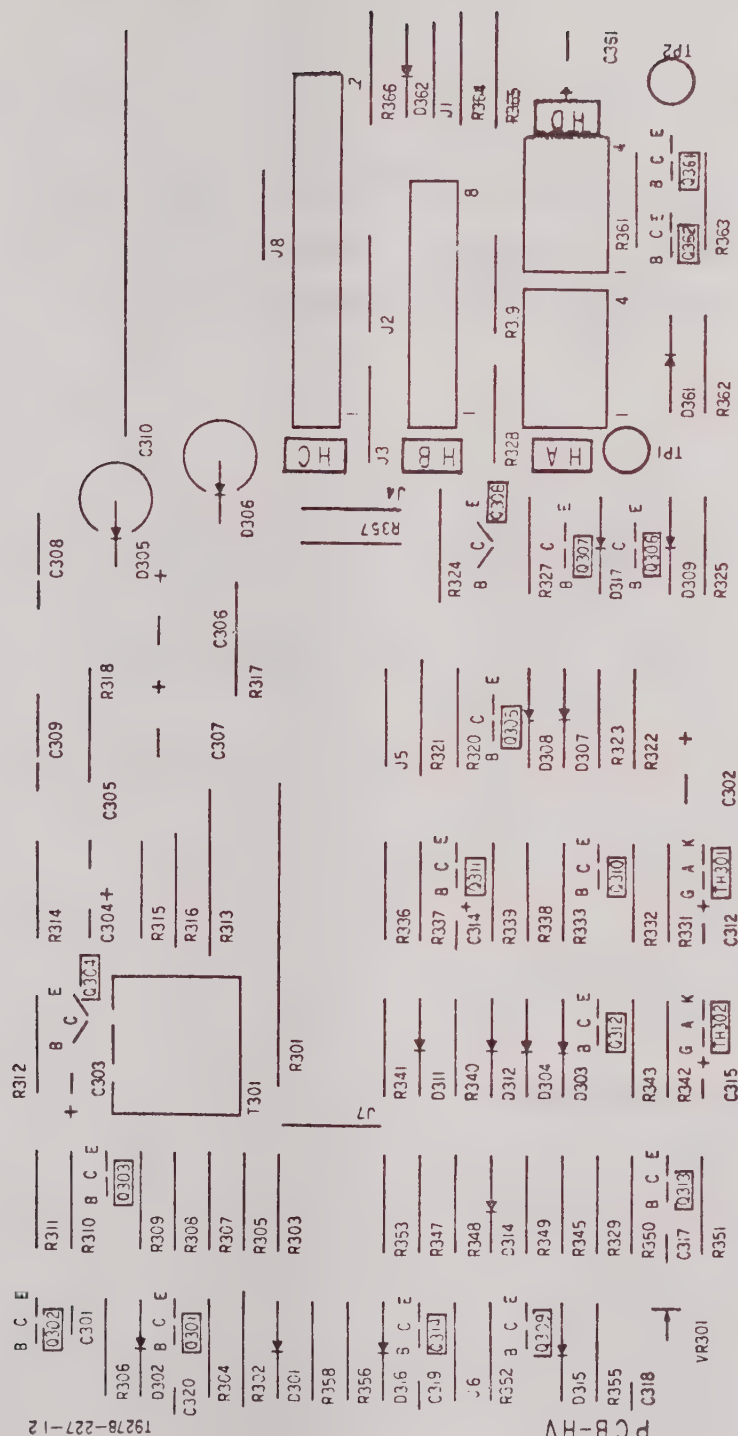


FIGURE 2-13. High Voltage PCB

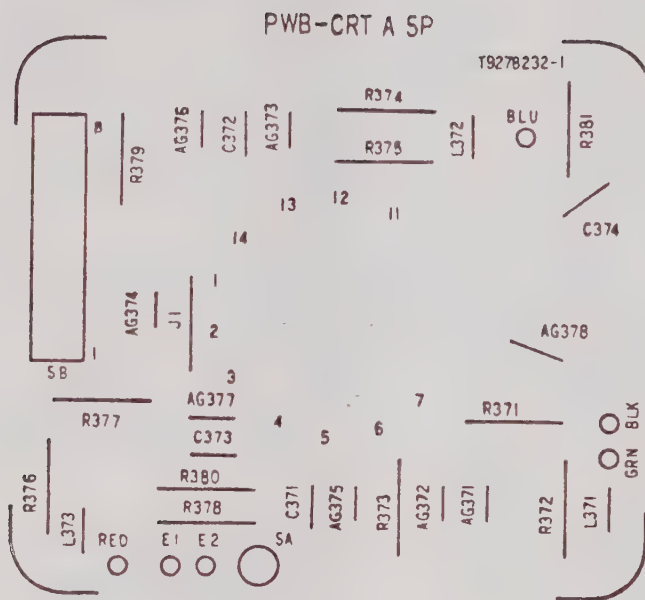


FIGURE 2-14. CRT PCB

3. CIRCUIT DESCRIPTIONS

3.1 DETAILED DESCRIPTION

This section contains detailed descriptions of circuit operation for Models C-3910 and C-3412 RGB Monitor. In reading this section, reference should be made to the monitor Schematic Diagrams contained in Section 5.

3.2 VIDEO AMPLIFIERS

The color monitor contains three video amplifiers, one for each primary color. These three amplifiers, for the red, green, and blue CRT guns are identical. Since the three amplifiers are identical, the operation of one channel (BLUE) is described here.

3.2.1 Video Preamplifier

The three video inputs are wired to BNC connectors located on the rear panel. A switch associated with each input allows selection of 75 ohm or high impedance termination. Blue video enters the monitor at connector J191 and is terminated by 75 ohm resistor R191 through switch SW191. Connector J192 allows for loop-through operation. Input video is AC coupled to the base of emitter-follower Q101 by capacitor C104. Capacitors C102, C103, and resistor R102 form a high-frequency emphasis network. The emitter of Q101 drives emitter-follower Q102. The output of the blue channel preamplifier at the emitter of Q102 drives the blue channel GAIN and CONTRAST controls, VR171A and VR176. These controls are located in the drawer. The GAIN controls for the three color channels are mechanically coupled together (operated from a single control) to provide convenient three color CONTRAST control. The CONTRAST controls are individually settable to allow matching of the CRT color levels.

3.2.2 Video Driver Amplifier

The blue video signal from the blue CONTRAST control enters the video driver amplifier (on the video card) at the emitter of Q201. The collector of common base amplifier Q201 drives emitter-follower Q202. Emitter-follower Q202 drives common base amplifier Q203 through capacitor C206. Capacitor C207 and resistor R211 form a high-frequency emphasis network. The collector of Q203 is AC coupled to the base of emitter-follower Q204. The DC bias for Q204 is supplied through R238 from bias amplifier Q210 and Q211. This DC bias maintains the video backporch at a set DC clamp level. The collector of Q205 forms a current source load for emitter-follower Q204. Cascade output amplifier formed by Q206 and Q207 are driven from the emitter of Q204. The collector of common emitter amplifier Q206 drives the emitter of common base amplifier Q207. Collector load resistor R225 returns to the positive 130 Volt power supply. Series and shunt peaking are provided by L201 and L202. The capacitor resistor networks in the emitter of Q206 formed by R221, R222, R223, C215, and C214 provide high-frequency peaking.

3.2.3 Backporch Clamp Circuit

A voltage divider formed by R226 and R227 provides an attenuated video output signal to the base of emitter-follower Q208. The emitter of Q208 drives a sample gate formed by diodes D204 and D205. A backporch pulse from the sync separator circuit drives the base of gate driver Q209. Normally Q209 is conducting, biasing diodes D204 and D205 to the nonconducting state. During the backporch time, interval Q209 is turned off by a negative pulse and resistor R230 provides forward bias to diodes D204 and D205. Thus allowing the DC level of the video backporch to be stored in C217. A differential amplifier (formed by Q210 and Q211), compares this stored backporch level with a reference clamp voltage level provided by the emitter of Q271. The output of the differential amplifier at the collector of Q211 provides bias to emitter-follower Q204. Thus, maintaining the backporch DC level at the reference

level. The reference voltage is settable by potentiometer VR271. The Darlington amplifier formed by Q272 and Q273 together with emitter-follower Q271, form a voltage regulator. The regulated output is at the emitter of Q271.

3.3 SYNC SEPARATOR

The sync separator is located on the video card and operates from the green video input in the case of internal sync, or operates from the separate sync input. This selection is made by sync selection switch SW451. The green video signal or separate sync signal is amplified and inverted by common emitter amplifier Q451. Emitter-follower Q452 buffers the amplified video and drives sync stripper Q453. The output of Q453 drives a second sync stripper Q454. The separated (positive) combined sync signal at the collector of Q454 is attenuated by R467 and R468 and is inverted and amplified by sync amplifier Q457 and fed to the control card. Amplifier Q455 inverts the separated sync signal to supply negative sync to the differentiator formed by C459 and R471. The Q456 is biased in the "on" state. Positive edges of the negative sync signal (which are the trailing edges of the horizontal sync pulses) drive Q456 to the "off" state. The output across R473 is a negative pulse during the backporch interval, which drives (Q209, Q229, and Q249) the backporch gate drivers.

3.4 DEFLECTION CIRCUITS

Deflection circuits consist of two PCB; PCB-DEFLECTION on the Deflection Block and PCB-CONTROL in the drawer.

3.5 VERTICAL CIRCUITS

The vertical circuits consist of the vertical oscillator, vertical pre-driver, vertical driver, vertical output transistor, and vertical deflection yoke.

A 35 Vp-p negative combined sync signal fed from PCB-VIDEO drives the horizontal circuits and the vertical sync filter consisting of R402, C401, R403, R404, and C402. These double integrators attenuate the horizontal sync pulses.

The vertical sync pulse is applied to the base of nonstable multi-vibrator (vertical oscillator) through C403, R409, and D405. The C403, R409, and D405 form the vertical sync pulse to achieve the well interlaced raster. Transistor Q401 and Q402 are nonstable multivibrators. The oscillator time constant is primarily determined by C404, R407, and the vertical hold control VR471. During the normal operation, the oscillator time constant is slightly longer than the vertical period. The vertical sync pulse applied to the base of Q402 synchronizes the vertical oscillator by turning Q402 on just prior to the end of the oscillator period.

During retrace time (primarily, it depends on the time constant determined by C406 and R410), C407 is charged through D407 by turning Q402 on. Turning Q402 on produces the vertical pulse voltage across R411 that drives the vertical blanking circuit on the PCB-VIDEO.

During vertical trace time, C407 discharges through vertical height control VR401 and R413 producing a sawtooth waveform. The D407 prevents the influence of vertical oscillator from discharging through C407. Signal feedback through the series resistors (R417 and R418) with deflection yoke is applied to C407 through vertical height control VR401 and vertical linearity control VR403 that is AC coupled. This feedback signal forming sawtooth voltage is similar to the oscillator sawtooth and reduces nonlinearity of oscillator sawtooth. That feedback makes the discharging current through C407 which flows constantly and produces the well formed sawtooth wave.

The vertical predriver consisting of Q403 and Q404 are generally known for differential amplifier and provides bias temperature compensation of output transistors Q406 and Q407.

The base voltage of Q403 is set by the zener voltage divider formed by R419 and R420. This keeps the stable bias condition and has the balanced voltage for that of Q404.

The emitter voltages of output transistors are divided by R423, R424, and R425, producing the bias for the base voltage of Q404. The method of this base bias makes the emitter voltage of output transistors stable.

The waveform fed from predriver Q403 is applied to the base of driver Q405. Vertical sawtooth waveform is fed through R423 which is connected to the base of Q404 drives Q405 to cut off during the vertical retrace time by its current feedback.

The operation of output transistors are well-known as the B-Class push-pull amplifier.

For the scanning of the upper screen (half cycle of vertical sweep), deflection yoke current flows through +130 Volts R432, R433, Q406, and C409. For the next half cycle (the scanning of the lower screen), Q407 begins to conduct.

Deflection yoke current reverses and flows through C409 and Q407 which scans the lower screen.

A sawtooth waveform developed across R417 and R418 drives the T & B PCC correction circuit and the dynamic convergence circuit through the buffer transistor Q705.

3.6 HORIZONTAL CIRCUITS

The horizontal circuits consist of the horizontal oscillator, phase-lock circuit, driver circuit (located on the PCB-CONTROL circuit card), the horizontal transformer T571 (located on the PCB-DEFL circuit card), and the horizontal deflection yoke. The PCB-CONTROL circuit card contains the horizontal oscillator Q504 and Q505, the horizontal predriver Q506, and the horizontal driver Q507. The horizontal oscillator incorporates a phase-lock circuit which locks the frequency and phase of the horizontal deflection current to the horizontal sync pulses stripped from the video input. As the oscillator, nonstable multi-vibration is employed and its free-running frequency by varying the bias voltage on the bases of oscillator transistors.

The sync signal stripped from the green video is amplified by Q457 (on the PCB-VIDEO card) and applied to the horizontal sync regenerator IC501. The IC501 is a one-shot multivibrator and produces the horizontal sync signal. The regenerated sync signal drives the pulse drivers Q501 and Q502. A horizontal sweep waveform is applied to C511 through the buffer amplifier Q703. These sync signals turn on AFC diodes D503 and D504, and clamp the voltage present at C511. During normal phase locked operation, the horizontal sync pulse clamps this voltage to the average voltage decided by horizontal hold control which is developed across C511. This clamping action produces a DC bias voltage at the junction of resistors R512 and R513, which is proportional to the phase difference between the sync pulse and the flyback waveform. Capacitor C512 filters this error signal which is applied to the bases of Q504 and Q505 through R524 and R525.

The phase error voltage controls the oscillator frequency to achieve phaselock.

Transistor Q506 is a predriver. Diode D507 that is connected to the base of Q506 shapes the oscillator waveform. Transistor Q507 drives

interstage transformer T501 which couples the drive signal to the base of horizontal output transistor Q551.

Capacitor C519 and resistor R534 provide waveshaping. The R583 and C582 on the DEFL circuit card develop a bias voltage to limit the base conduction of Q551.

Output transistor Q551 is driven into conduction for approximately 40 microseconds at the end of each horizontal sweep. The Q551 is turned off at the beginning of the retrace period.

Retrace time is determined by the resonant frequency of parallel circuit formed by the inductance of the horizontal deflection yoke, the inductance of horizontal transformer T571, C572, and C573. During retrace time, a half cycle of oscillation occurs at this resonant frequency with the collector of Q551 swinging positive. When the half cycle is completed the collector of Q551 begins to swing negative causing damper diode D571 to conduct. When D571 conducts, the resonant frequency of the horizontal circuit is changed to produce the horizontal sweep, by the shorting of capacitors C572 and C573.

During sweep time, the resonant frequency is determined by the horizontal yoke inductance and capacitors C572 and C573.

Current from the yoke flows through diode D571 for approximately half of the horizontal sweep time, at which point, the current reaches zero and reverses. The reversed yoke current flows through Q551 (which is turned on during the last half of the sweep time) until the next retrace period. The horizontal yoke is grounded through linearity correction AC coupled inductor L571 on the DEFL circuit card.

Inductor L571 is magnetically biased and provides horizontal linearity correction.

3.7 CONVERGENCE CIRCUITS

Convergence circuits are mounted on the drawer. Signals for convergence compensation are generated from horizontal and vertical scanning signals to drive convergence yoke L891.

Convergence circuits generate two sorts of waves; one is of horizontal source and the other is of vertical source. These two sorts of signals are mixed in the convergence circuits. Then these signals drive three coils corresponding to the guns R, G, and B.

The vertical convergence circuits are fed with the signal across the resistors R417 and R418. This signal is applied to a Miller's integrator Q819 through Q822. Also this signal is applied to a Schmitt's trigger circuits of Q815 and Q816 to enable us independent adjustment mentioned as follows. At first, vertical sawtooth wave is converted to parabolic wave through a Miller integrator, of which integrating parameter is dependent on C824 and R846. This parabolic signal is generated on the collector of Q818; then the signal is amplified through a emitter-follower Q822 to drive side PCC circuit. This emitter-follower is effective to improve Miller's integrator characteristics. This parabolic signal is applied to the buffer amplifier Q825 and then drives variable resistors VR8E1 through VR8E6 which are to adjust vertical convergence.

This signal is clamped at the base of Q825 by a diode D822 in order to eliminate the shift of convergence at the center of CRT. On the other hand, this parabolic signal is fed to amplitude/DC - level control circuits Q823 and Q824. This parabolic signal is inverted through Q823 and modulates horizontal convergence signal on Q824 after being adjusted to it's DC level on Q824 by VR802. The other sawtooth wave drives a Schmitt's trigger circuits Q815 and Q816; and turns Q817 "on" for antecedent half period but turns if "off" for the following half period. The signal generated on the collector of Q817 is clamped by D820 to the level +60

Volts, so 60 Volts square wave is generated on the collector of Q817. The inverted 60 Vp-p square wave switches the vertical parabolic wave which are adjusted by their amplitude by VR8E1 through VR8E6, through D834 through D837, and D8C1 through D8C6. That is to say, outputs from VR8E4 through VR8E6 are cut-off when Q817 is "on". But when Q817 is "off", these outputs are fed to the next stage. So the signal output is free from interference during undesired periods.

Output of the Q818 is in the inverse phase to that of Q817, so the outputs from VR8E1 through VR8E3 are active when Q816 is "on". For instance, VR8E1 can adjust the amplitude of parabolic wave but this output is disabled when Q818 is "on", so this can adjust only for half period.

The other half period is completed by VR8E4 and these signals are combined by D8D1, D8D4 and then they drive output transistor to complete compensation.

Horizontal convergence signals are composed from horizontal retrace pulse of 250 Vp-p amplitude and a parabolic wave from T502 which is step-up transformer of horizontal parabolic wave across C521, C522 on the PCB-CONTROL.

One of the H - retrace pulses is integrated by R801 and C802, then converted to horizontal sawtooth wave signal. Then this signal is applied to a Schmitt's trigger circuits consisting of Q801 and Q802. The output of the Schmitt's trigger circuits is "on" for antecedent horizontal half period and "off" for the following half period. So 60 Vp-p square wave is generated on the collector of Q803. The Q804 is for the purpose of improving set-up time of the collector signal on Q803.

The Q805 is a inverter to generate square wave inverse to that on Q804. These square waves are useful to adjust convergence in a area independent from the other convergence areas. Three diodes, D832, D833, and

D836 are connected in series in order to avoid disturbance of compensation signal caused by leak of switching pulse through capacitances in their junctions.

The other parabolic signal goes through C809 and then the signal is clamped by D806 for the sake of eliminating shift of convergence at the center of CRT.

The parabolic signal is stepped up in T801 and divided in two at the secondary winding. These parabolic waves are clamped by D814 for bottom clamping and by D813 for top clamping. Upper and lower side of these signals are symmetrical. These parabolic signals are increased or decreased by VR8D1 through VR8D6.

The input signal is amplified by Q806 and the input signal to Q807 is modulated by the output from Q824 along vertical axis. On the other hand, parabolic signal through D811 is modulated and vertical frequency components of the signals are diminished through C815 of small capacitance. So only horizontal frequency components are fed to Q809. The D815 clamps the signal to keep the center convergence and the signal is amplified through Q809 and utilized to compensate convergence at corner of CRT.

Vertical square wave is applied to the base of Q810 through D817, so no input signal is fed to Q811 when Q818 is turned "on". Then the compensation signal for corner is effective only when Q818 is "off". On the contrary, Q812 is supplied with corner compensation signal only when Q816 is "off".

The output from Q811 is transferred to variable registers VR8B1 through VR8B6 for corner compensation. To explain VR8B1 for example, horizontal parabolic wave is generated across the variable register. This signal is parabolically modulated by the vertical signal during vertical half periods. This wave is adjusted by it's amplitude by VR8B1 and drives out-

put transistor through D8E1. But on the other hand, this point is connected to Q803 through D8A1, D831, and D803. The Q803 is turned on for antecedent period of horizontal cycle which is corresponding to the left half side on CRT. So the output transistor is driven only for upper right quarter of CRT. So this signal is suitable for upper right area compensation.

As described above, combination of the variable registers and R.G.B. output transistors enable us to compensate at upper right corner independently from the other areas.

Variable registers VR8B1 through VR8B6, and VR8C1 through VR8C6 are designed to compensate upper right, upper left, under right, under left corners. The other signal applied to Q807 is transferred to VR8A1 through VR8A6 through Q808. This signal is a parabolic signal modulated by vertical signal and compensates overall areas along horizontal axis. The corner compensation signal mentioned above is for compensating the rest of the parts that are excluded by the modulation. Green circuits for example, horizontal output transistors are a pair of Darlington connected transistors Q827, Q828, and the vertical ones are Q829 and Q830.

Coil for green compensation is loaded between the collectors and +60 Volt power source. The R876 is loaded across the coil to damp resonant current generated on the coil.

3.7.1 Pincushion Correction

Two pincushion correction circuits are contained in the PCB-CONTROL circuit card; a side pincushion correction circuit, and a top/bottom pincushion correction circuit. The side pincushion correction circuit modulates the raster width as a function of vertical deflection. The top/bottom pincushion correction circuit modulates the vertical deflection amplitude as a function of horizontal deflection.

The side pincushion correction circuit is composed of transistors Q701 and Q702. Transistor Q702 amplifies the parabolic waveform applied through PCB-CONV. This voltage is adjusted by the side PCC Amp VR701 and drives Q701. The Q701 is the buffer amplifier and produces the parabolic modulation of the horizontal power supply through C702. The correction voltage modulates the horizontal yoke current to correct side pincushion distortion.

The top/bottom pincushion correction circuit is composed of the buffer amplifier Q704, the modulator IC701, and the buffer amplifier Q705.

Horizontal sawtooth waveform is applied to the network circuits for PHASE control and is integrated by C711.

This integrated waveform is applied to IC701 through the buffer amplifier Q704.

Vertical yoke current flows through the feedback resistors R417 and R418 and is applied to the buffer amplifier Q705. This vertical sawtooth waveform is adjusted by the T & B PCC Amp control and drives IC701 through the buffer amplifier Q705.

The modulated output signal is applied to the base of vertical driver Q404 through R730 and C714. This correction voltage modulates the vertical yoke current to correct top/bottom pincushion distortion.

3.7.2 Horizontal Voltage Control Circuit

The horizontal voltage control circuit is located on the control circuit card in drawer. The control circuit operates to keep the constant horizontal width for the change of line rate.

This circuit maintains the operation from the 15.75 KHz line rate to the 18 KHz line rate.

The control circuit is composed of the error amplifier Q971, Q972, and the horizontal voltage regulator Q571, Q752, and Q552. To detect the output voltage, the rectified horizontal retrace pulse is utilized to keep the constant width.

The rectified voltage source is developed across a capacitor C581 in the DEFL circuit. The error amplifier Q971 and Q972 compares the attenuated rectified voltage source, applied to its base through VR971 with the zener voltage of D971. The amplified difference voltage developed across R582 drives the base of Q522 to maintain a regulated output voltage level. Potentiometers VR971 and VR972 adjust the output voltage.

The VR971 is used to provide horizontal width adjustment. The VR972 is set to provide the underscan width with switch S971.

3.8 LOW VOLTAGE DC POWER SUPPLIES

The primary DC power sources consist of rectifier circuits located on the power circuit card, a +130 Volts DC regulator, a +60 Volts DC regulator, and +100 Volts DC regulator located on the POWER-REG card.

Other low voltage power sources consist of a positive brightness voltage regulator, a negative brightness voltage source located on the video circuit card, and a +20 Volts DC power source located on the DEFL circuit card.

3.8.1 Power Rectifier Circuit

The input AC line voltage is applied to connector PA on the power circuit card through connector PG, connector FC, and connector PH on the connector card and AC power switch S991. When S991 turns "on", AC line voltage is applied to the primary of the power transformer through fuse F902 or F901. A jumper plug PJ must be placed in the appropriate position depending on AC line voltage.

Rectifier diodes D901, D902, D903, and D904 produce unregulated +145 Volts DC across filter capacitor C905, through fuse F904. Unregulated +75 Volts DC is produced by the rectifier bridge formed by diodes D905, D906, D907, D908, and C910. The rectifier circuit consists of D909, D910, D911, and D912. Also the C915 produces unregulated +125 Volts DC.

These unregulated DC voltages are applied to the POWER-REG circuit card and regulated to DC voltages.

3.8.2 Positive Voltage DC Regulators

The 130 Volts DC regulator, the 100 Volts DC regulator and the 60 Volts DC regulator is located on the POWER-REG circuit card. The operation of 130 Volts regulator circuit is described here for the same operation of each regulator circuits.

Unregulated +145 Volts DC applied to fuse F931 is regulated by series pass transistor Q991.

Output transistor Q991 is driven by emitter-follower Q931. The base of Q931 is controlled by error amplifier Q933. Transistor Q933 compares the attenuated regulator output voltage, applied to its base through VR931, to the zener voltage D932. The amplifier difference voltage at the collector of Q933 is applied to the base of Q931, maintaining the regulator output at +130 Volts DC. Potentiometer VR931 adjusts the output voltage level.

Transistor Q932 provides short circuit protection by limiting the output current.

The Q932 is normally biased in the nonconducting state by resistors R935 and R936.

As the output current increases the voltage developed across R933 increases.

During overload conditions the current through R935 causes Q932 to conduct, which clamps the base of Q991 to limit the output current.

3.8.3 Positive Brightness Source

The +70 Volts DC brightness source is located on the video circuit card. This voltage is obtained to regulate +130 Volts DC. The voltage regulator is composed of Q601 and Q602. A voltage of +70 Volts DC is developed and applied to brightness potentiometer VR691 via PCB-CONNECTOR.

3.8.4 Negative Brightness Voltage Regulator

A negative brightness voltage regulator is located on the video card. This voltage is implemented by transistors Q603 and Q604. This voltage regulator supplies a negative bias of -90 Volts DC to the brightness control VR691. A negative unregulated voltage of -120 Volts DC is developed across capacitor C602 by the rectifier action of diode D602. A horizontal retrace pulse from horizontal output transformer T571 is rectified by diode D602. This unregulated -120 Volts DC is applied to the collector of series pass transistor Q603. The regulated -90 Volts DC output at the emitter of Q603 is supplied to brightness control VR691. A voltage divider formed by resistors R607 and R608 divides between the regulator output voltage and the positive brightness reference voltage across C601. The Q604 compares the base voltage of Q604 with GND. The amplified difference voltage at the collector of Q604 drives Q603 to maintain a regulated output.

3.8.5 Positive +20 Volt DC Source

An unregulated +27 Volts DC voltage source is developed across capacitor C578 on the DEFL circuit card.

A retrace pulse from horizontal output transformer T571 is rectified by diode D574, to produce +20 Volts DC through regulator transistor Q573.

The regulated +20 Volts DC powers low voltage video, vertical circuits, and convergence circuits.

3.9 HIGH VOLTAGE CIRCUITS

The CRT anode voltage is produced by rectification of a horizontal retrace pulse obtained from the high voltage winding of horizontal output transformer (FBT) T591.

High voltage shall be independent of anode current, in order to obtain stable performance.

The input horizontal pulse produced on the PCB-DEFL is applied to the monostable multivibrator circuits.

The circuits are composed of Q301 and Q302. The duty of input is shaped to have suitable duty cycles by R307 and C301.

This pulse is fed to the output circuits through the buffer amplifier composed of Q303 and driver transistor Q304.

Transformer T304 which is load of Q304, are the impedance transformer and drives the output transistor Q392.

The operation of output circuits is as same as that of deflection output circuits.

The pulse at collector Q392 is stepped up by FBT and high voltage is obtained from the single rectifier. High voltage is divided by R591 and R356.

The divided voltage is fed to the differential amplifier composed of Q305 and Q306 through the buffer amplifier Q314 and HV control VR301 and buffer amplifier Q309. The base voltage that is in proportion to the high voltage is compared with the zener voltage of D307. The differential voltage is amplified and drives the HV control transistor Q352. If high voltage cannot keep the normal condition the differential voltage controls the emitter voltage of transistor Q352.

3.10 HIGH VOLTAGE HOLD-DOWN CIRCUITS

High voltage hold-down circuits are located on the HV circuit card. If high voltage reaches to a certain designed level above 25 KV, at least either of protector circuits begins to operate and cuts off high voltage drive circuits.

Anode voltage is divided by R591 (R-HV) and R356. The divided voltage is fed to the comparator composed of Q313 through the buffer amplifier Q314, and also to high voltage regulator through HV control VR301.

Transistor Q313 is turned off by the bias voltage to its emitter through R347, and transistor Q312 is turned off.

If high voltage increases owing to some trouble, the base voltage of Q313 becomes higher than its emitter voltage, and begins to turn-on Q313 and Q312.

The collector current of Q312 triggers TH302. As TH302 is turned on, zener voltage +12 Volts that generates the high voltage drive circuits is grounded and high voltage is dropped to zero. The operation of other safety circuits is almost same as that of above described circuits.

The focus voltage is obtained from the top of T591 and is in proportion to the high voltage that is obtained from the top winding of T591. That is, the focus voltage is utilized for the second detector.

3.11 CRT SCREEN GRID VOLTAGE

Screen grid bias for the CRT is obtained by rectification of the horizontal retrace pulse generated at the collector of horizontal output transistor Q551. Diode D572, located on the DEFL circuit card, rectifies this retrace pulse to produce a positive potential of approximately 750 Volts DC across filter capacitors C575 and C576.

This screen bias voltage is applied to the screen grid circuit on the CRT circuit card through screen control VR on the front panel in the drawer. Controls VR391, VR392, and VR393 adjust the red, green, and blue screen grid potentials. During normal operation, the screen voltages are approximately +500 Volts DC. Screen voltages are adjusted to equalize the screen brightness produced by the three color beams.

3.12 FOCUS VOLTAGE

The focus voltage is obtained from the top of FBT by a voltage divider formed by potentiometer VR591 and resistor R592 and R593.

Resistor R592, R593, and potentiometer VR591 are a potted assembly located on deflection block.

During normal operation, the focus voltage is supplied approximately 4.5 KV to the focus anodes of CRT V571.

3.13 HEALTH CHECK CIRCUIT

The health check circuit, located on the HV circuit card, functions to illuminate a light emitting diode (LED) D991 when the CRT anode high voltage is not excessive and the horizontal deflection circuit is operating properly. High voltage is generated from +100 Volts DC power supply and horizontal retrace pulse that is used for the HV drive pulse.

The voltage across C361 that is obtained to rectify the retrace pulse generated by FBT, and is utilized to illuminate LED. The Q362 is a detector to judge where the operation of deflection circuit is proper or not. The Q361 is a LED driver. When deflection circuit is operating properly, Q362 conducts and makes Q361 turn-on. For the conduction of deflection power supply Q552, the detector Q362 is not biased to the "on" state and current ceases to flow through Q361 and LED. The +100 Volts DC power supply is biased by the R941 through the output of +130 Volts DC power supply.

Therefore, +130 Volts DC power supply is one of the LED drivers. The horizontal retrace pulse that drives the high voltage circuits, is generated by +100 Volts DC power supply and +60 Volts DC power supply. The LED D991 will not illuminate if a failure of these supplies occurs. When high voltage exceeds the operating level of protectors, high voltage drops to GND and health check circuit operates. The remote connector on the back panel allows a remote LED diode to be connected to the health check circuit.

3.14 BRIGHTNESS AND BLANKING

The blanking circuit provides negative blanking pulses to the CRT control grids during the vertical and horizontal retrace periods, and generating negative blanking pulses at its collector. The output of Q608 is buffered by emitter-follower Q609, which drives the CRT control grids through capacitor C611. Diode D616 improves blanking pulse rise time at turn-on. When Q608 is turned on at the beginning of a blanking pulse, its collector swings negative causing diode D616 to conduct. Thus discharging capacitor C611 through the collector of Q608.

3.15 AUTOMATIC BEAM LIMITER

The automatic beam limiter (ABL) circuit, located on the video circuit card, is implemented by transistors Q605, Q606, and Q607. The ABL circuit functions to limit the CRT beam current to a level set by potentiometer VR601.

High voltage rectifier current, from horizontal transformer T591 returns to ground through resistor R319 on the high voltage circuit card. A DC voltage developed across resistor R319 is proportional to the CRT beam current. This negative DC voltage developed across R319, is filtered by capacitors C604 and C605 and applied to the base of transistor Q605. The differential amplifier formed by transistors Q605 and Q606, compares the voltage across R319 with the reference level set by potentiometer VR601. If the voltage drop across R319, produced by the beam current exceeds the level set at VR601, transistor Q605 conducts and turns on transistor Q607. The collector of transistor Q607 pulls the CRT grid voltage negative to limit the beam current.

4. PARTS LIST

MGA SYMBOL NO.	PART NAME AND DESCRIPTION		RAMTEK PART NO.
R532	R-FUSE	$\frac{1}{2}W$ 1.2K	3130035-01
VR301	VR-SF	$\frac{1}{2}W$ B-8K	3130036-01
VR271	VR-SF	$\frac{1}{2}W$ B-5K	3130037-01
VR402			
VR601			
VR801			
VR972	VR-SF	$\frac{1}{2}W$ B-10K	3130038-01
VR802	VR-SF	$\frac{1}{2}W$ B-20K	3130039-01
VR932	VR-SF	$\frac{3}{4}W$ B-1K	3130040-01
VR933			
VR931	VR-SF	$\frac{3}{4}W$ B-2K	3130041-01
VR503	VR-SF	$\frac{3}{4}W$ B-200	3130042-01
VR703			
VR404	VR-SF	$\frac{3}{4}W$ B-1K	3130043-01
VR403		$\frac{3}{4}W$ B-10K	3130044-01
VR8A1-8A6			
VR8B1-8B6			
VR8C1-8C6			
VR8D1-8D6			
VR8E1-8E6			
VR401	VR-SF	$\frac{3}{4}W$ B-20K	3130045-01
VR701			
VR702			
VR704			
VR971			
VR501	VR-SF	$\frac{3}{4}W$ B-50K	3130046-01
C910	C-ELE	160V 470MF	6710039-01
C905	C-ELE	200V 600MF	6710040-01
AG371	AIR GAP		2310014-01
AG377			

4. PARTS LIST (Continued)

MGA SYMBOL NO.	PART NAME AND DESCRIPTION	RAMTEK PART NO.
AG318	FOCUS GAP	2310015-01
Q932	TRANSISTOR 2SC620-CD	3210006-01
Q935		
Q938		
Q301-Q303	TRANSISTOR 2SC620-D	3210006-01
Q351		
Q451-Q453		
Q455-Q506		
Q702-Q705		
Q801		
Q802		
Q815		
Q816		
Q171	TRANSISTOR 2SC712-BC	3210046-01
Q405	TRANSISTOR 2SD478-C	8199132-01
Q406		
Q503		
Q573		
Q574		
Q824		
Q828		
Q829		
Q832		
Q833		
Q736		
Q837		
Q206	TRANSISTOR 2SC594-0Y	3210003-01
Q226		
Q246		
Q509	TRANSISTOR 2SB528-CD	3210007-01
Q603		
Q605		
Q606		
Q207	TRANSISTOR 2SC515A	3210047-01
Q227		
Q247		

4. PARTS LIST (Continued)

MGA SYMBOL NO.	PART NAME AND DESCRIPTION	RAMTEK PART NO.
Q602 Q608 Q609		
Q202 Q203 Q222 Q242 Q245 Q310 Q312	TRANSISTOR 2SA628-EF	3210002-01
Q454 Q456	TRANSISTOR 2SA628-E	3210002-01
Q403 Q404 Q504 Q505 Q819 Q820	TRANSISTOR 2SA628-F	3210002-01
Q101 Q102 Q111 Q112 Q121 Q122 Q201 Q204 Q205 Q211 Q224 Q225 Q241 Q244 Q245	TRANSISTOR 2SC710-CD	3210001-01
Q701	TRANSISTOR 2SC711AG	3210014-01
Q209 Q229 Q249	TRANSISTOR 2SC869-C	3210048-01

4. PARTS LIST (Continued)

MGA SYMBOL NO.	PART NAME AND DESCRIPTION	RAMTEK PART NO.
Q457 Q804 Q806 Q807 Q809 Q810 Q812 Q821 Q830 Q831 Q834 Q835 Q833	TRANSISTOR 2SC869-D	3210049-01
Q407	TRANSISTOR 2SB568-C	3210050-01
Q352 Q991 Q994	TRANSISTOR 2SC1106	3210051-01
Q502	TRANSISTOR 2SC1210-D	3210052-01
Q552	TRANSISTOR 2SC1586	3210053-01
Q309 Q311 Q314	TRANSISTOR 2SC1312-F	3210054-01
Q508	TRANSISTOR 2SC1749-CD	3210055-01
Q304 Q308 Q571 Q937 Q601 Q607 Q808 Q939 Q811 Q813 Q822 Q972 Q823 Q825	TRANSISTOR 2SC1749-D	3210005-01

4. PARTS LIST (Continued)

MGA SYMBOL NO.	PART NAME AND DESCRIPTION	RAMTEK PART NO.
Q931 Q933 Q934 Q936		
Q208 Q228 Q248 Q271-Q273 Q305-Q307 Q572 Q971	TRANSISTOR 2SC1515-K	3210013-01
Q507	TRANSISTOR 2SC1722-BK	3210056-01
Q803 Q805 Q817 Q818	TRANSISTOR 2SC2024-GB	3210057-01
Q401 Q402 Q501	TRANSISTOR 2SA697-D	3210058-01
Q210 Q211 Q230 Q231 Q250 Q251 Q352 Q604	TRANSISTOR 2SA778A-K	3210059-01
Q351 Q551	TRANSISTOR 2SC1413	8199125-01
D606	DIODE IN60	8199116-01
D614	DIODE ZENER MZ205	3210062-01
D305 D306 D571 D572	DIODE SB-2C	3210063-01

4. PARTS LIST (Continued)

MGA SYMBOL NO.	PART NAME AND DESCRIPTION	RAMTEK PART NO.
D201	DIODE 1S2076	3210064-01
D206		
D217		
D216		
D226		
D227		
D302		
D308		
D309		
D311		
D312		
D314		
D317		
D351		
D403-D408		
D451		
D452		
D503-D506		
D603		
D607		
D609		
D610		
D613		
D615		
D616		
D806-D810		
D819		
D935		
D8D1		
D8D6		
D937		
D8B1-D8B6	DIODE 1S2076A	3210065-01
D204		
D205		
D214		
D215		
D224		
D225		
D803		
D813		
D814		
D824		

4. PARTS LIST (Continued)

MGA SYMBOL NO.	PART NAME AND DESCRIPTION	RAMTEK PART NO.
D831-D837 D8A1-D8A6 D8C1-D8C6		
TH301 TH302	THYRISTOR GR02AM-4	3210066-01
D202 D212 D222 D507	DIODE ZENER MZ212	3210067-01
D270 D401 D402 D601 D932 D936 D940 D971	DIODE ZENER MZ207	3210068-01
D304 D305	DIODE ZENER MZ206B	3210069-01
D307	DIODE ZENER MZ207B	3210070-01
D611 D612	DIODE RA-1Z	3210071-01
D825 D828 D931 D933 D934 D937	DIODE RA-1	3210072-01
D901-D912 D203 D213 D223 D574 D575 D577 D605	DIODE RA-1A	3210073-01

4. PARTS LIST (Continued)

MGA SYMBOL NO.	PART NAME AND DESCRIPTION	RAMTEK PART NO.
D617	DIODE ZENER EQA01-06	3210074-01
D508 D576	DIODE ZENER EQA01-21R	3210075-01
D578	DIODE ZENER EQA01-07S	3210076-01
D501 D502	DIODE ZENER EQ401-05S	3210077-01
D602 D604 D608 D806 D811 D812 D815 D817 D820 D822	DIODE L1F-1Z	3210078-01
D301 D573 D802	DIODE L1F-1	3210079-01
D991	DIODE	3210080-01
IC701	IC M5109P	1310034-01
IC501	IC SN74LS00N	1301133-00
F904 F905	FUSE - UL S-1A	2310016-01
F901	FUSE - UL S-1.5A	2310017-01
F905	FUSE - UL S-2A	2310018-01
F902	FUSE - UL S-3A	2310019-01
F903	FUSE - UL S-5A	2310020-01

4. PARTS LIST (Continued)

MGA SYMBOL NO.	PART NAME AND DESCRIPTION	RAMTEK PART NO.
F931 F933	FUSE 1A	2310021-01
F932	FUSE 2A	2310022-01
DY	DEFL YOKE (C3910)	6910024-01
L571	L-LIN MILI 23	6910025-01
T301 T501	J H DRIVE	6910026-01
J502 J801	J PULSE SD122AP	8130018-01
L572 L573	L PEAK 4.7MHK	6910027-01
T503	J FOCUS	6910028-01
S401 S501	SW SL	9060011-01
S191-S194	SW SL ST0210	9060012-01
S451	SW SL HSW05667-30	9060013-01
S971	SW SL	9060014-01
S991	SW ROCKER	9060015-01
S992	SW ROCKER	9060016-01
J191-J198	RECEPTACLE BNC	8640046-01
VR391-VR393	VR-SF	3130047-01
VR171-VR173	VR STD V24L5G(3R)NB500	3130048-01
VR174-VR175 VR619	VR STD	3130049-01
VR571	VR STD	3130050-01

4. PARTS LIST (Continued)

MGA SYMBOL NO.	PART NAME AND DESCRIPTION	RAMTEK PART NO.
VR471	VR STD	3130051-01
S174	SW SLIDE	9060017-01
S391-S393	SW SLIDE	9060018-01
440C012B1	SOCKET CRT	8640044-01
449D014A1	SOCKET TR	8640045-01
	HOLDER TR	8130051-01
641D357A1	SAFETY COVER	8130019-01
704D64A1	KNOB HB 17S (LEY)	8130052-01
590B512A1	CONTROL PANEL	8130020-01
590B513A1	BACK BOARD (C3910)	8130021-01
701A120A1	MASK 20 (C3910)	8130022-01
710A018A1	CABINET (C3910)	8130023-01
711A008A1	FRONT PANEL (C3910)	8130024-01
254P454A1	CRT ST2019CEB22-B (C3910)	8130025-01
242D125A1	AC POWER CORD	3870006-01
4252D049A1	PLUG AC	3870007-01
709C016A1	HANDLE (C3910)	0710025-01
549P002A22	DY HOLDER (C3910)	6910029-01
221D009A1	INSULATOR	8130050-01
264P03701	DIODE HVT-30SS/ESJA31-20	3210060-01
264P037A2	DIODE HVT-20SS/ESJA35-12	3610061-01
T927C197-1	ASSY CONVERGENCE (Coil)	6910036-01

4. PARTS LIST (Continued)

MGA SYMBOL NO.	PART NAME AND DESCRIPTION	RAMTEK PART NO.
T927B230-2	ASSY PWB CONNECTOR	7910021-01
T927B230-1	ASSY PWB CONNECTOR	7910022-01
T927B227-2	ASSY PWB HV (C3412)	7910023-01
T409C014-1	COIL DEGAUSSING (C3412)	6910030-01
590B526A1	BACK BOARD (C3412)	8130026-01
710A019A1	CABINET (C3412)	8130027-01
711A009A1	FRONT PANEL (C3412)	8130028-01
701A122A1	MASK (C3412)	8130029-01
709D027C3	HANDLE (C3412)	8130030-01
549P002A1	DEFL YOKE HOLDER (C3412)	6910031-01
330P067A1	DEFL YOKE (C3412)	6910032-01
254P408A4	CRT ST1419CB22-B (C3412)	8130032-01
T927B234-1	ASSY TRANS POWER	7910032-01
T927B196-1	ASSY FOCUS	7910033-01
T334B058-1	TRANS FBT	6910033-01
T409C043-1	COIL DEGAUSSING (C3910)	6910034-01
T334B159A1	TRANS FLYBACK (T571)	6910035-01
T927B215-1	ASSY PCB VIDEO	8199006-00
T927B264-2		7910036-01
T927B217-1	ASSY PCB CONV	8199005-00
T927B217-2		

4. PARTS LIST (Continued)

MGA SYMBOL NO.	PART NAME AND DESCRIPTION	RAMTEK PART NO.
T927B226-1	ASSY PCB CONTROL	8199010-00
T927B227-1	ASSY PCB HV (C3910)	8199008-00
T927B227-2		7910037-01
T927B228-1	ASSY PCB POWER	8199009-00
T927B229-1	ASSY PCB REG	8199011-00
T927B231-1	ASSY PCB DEFL	8199007-00
T927B282-1		7910038-01
T927B232-1	ASSY PCB CRT	8199014-00
T927B232-2		7910039-01
T927C261-1	D-BL PCB	7910040-01

NOTE: Where two part numbers are listed, the top number is effective for serial numbers 9101300 and lower. The bottom number is effective for serial numbers 9101301 and higher.

5. FLOW CHARTS

The following is a list of the Flow Charts that are provided to assist in Circuit Fault Isolation.

Flow Chart, Fault Isolation, No Raster C-3910 Trouble Shooting	5-2
Flow Chart, Fault Isolation, +130 VDC Abnormal (2)	5-3
Flow Chart, Fault Isolation, +100 VDC Abnormal (3)	5-4
Flow Chart, Fault Isolation, +60 VDC Abnormal (4)	5-5
Flow Chart, Fault Isolation, Horizontal Circuit (5)	5-6
Flow Chart, Fault Isolation, Abnormal ABL (6)	5-7
Flow Chart, Fault Isolation, Abnormal HV Circuit (7)	5-8
Flow Chart, Fault Isolation, No Sync (8)	5-9
Flow Chart, Fault Isolation, No Video (9)	5-10
Flow Chart, Fault Isolation, Inoperative DC Restore (10)	5-11
Flow Chart, Fault Isolation, Vertical Circuit Abnormal (11)	5-12
Flow Chart, Fault Isolation, Convergence Abnormal (12)	5-13

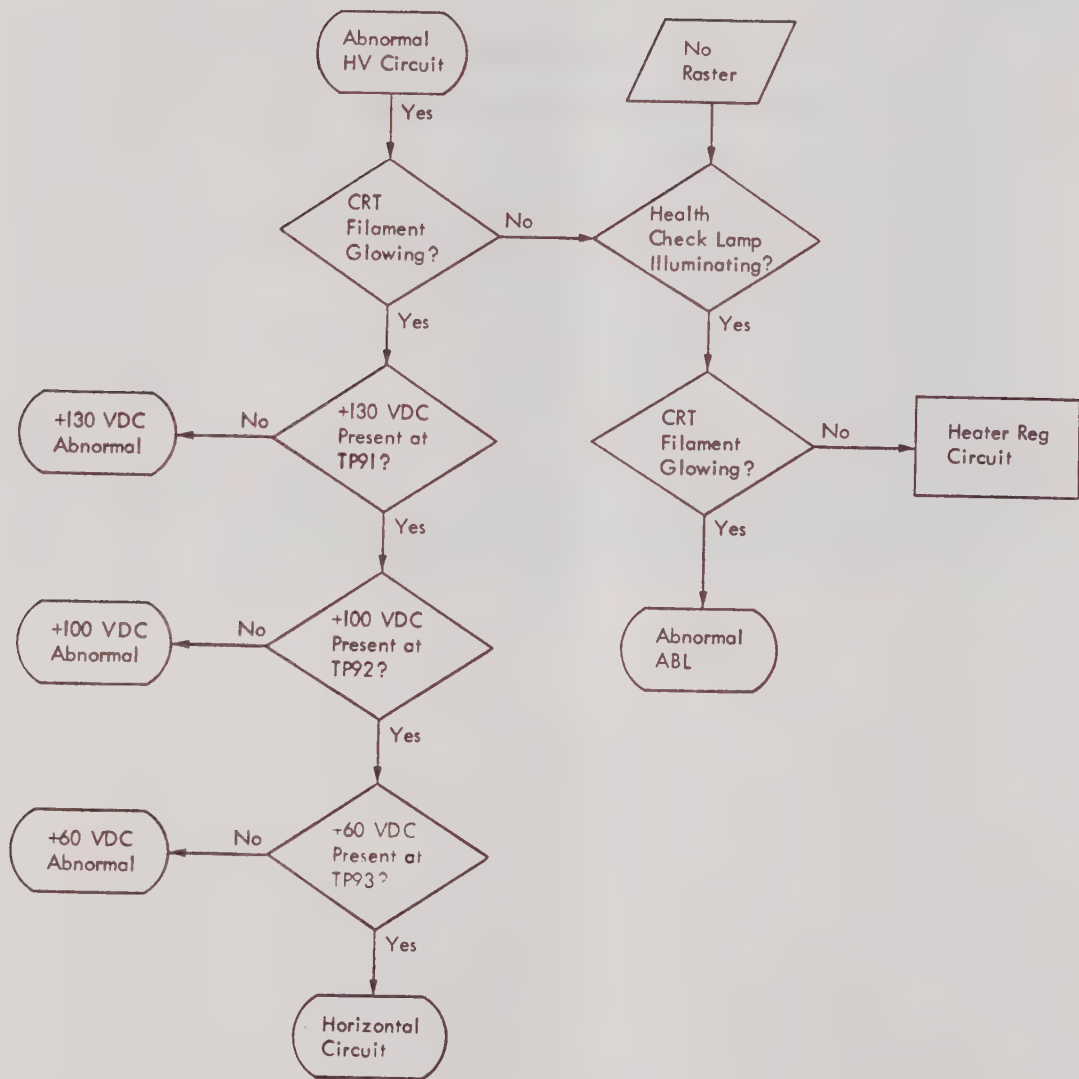


FIGURE 5-1.

Flow Chart, Fault Isolation, No Raster C- 3910 Trouble Shooting

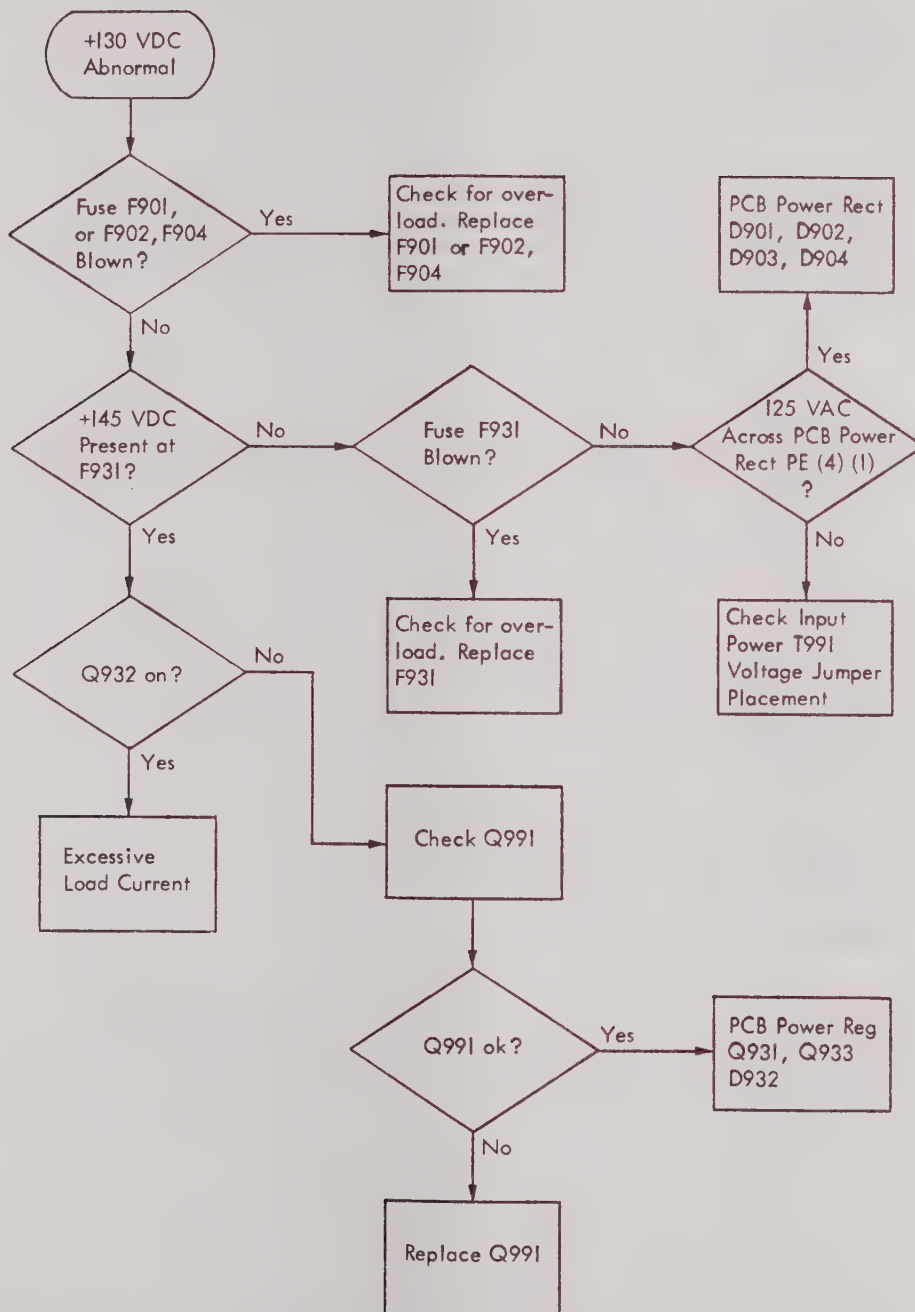


FIGURE 5-2.

Flow Chart, Fault Isolation, +130 VDC Abnormal (2)

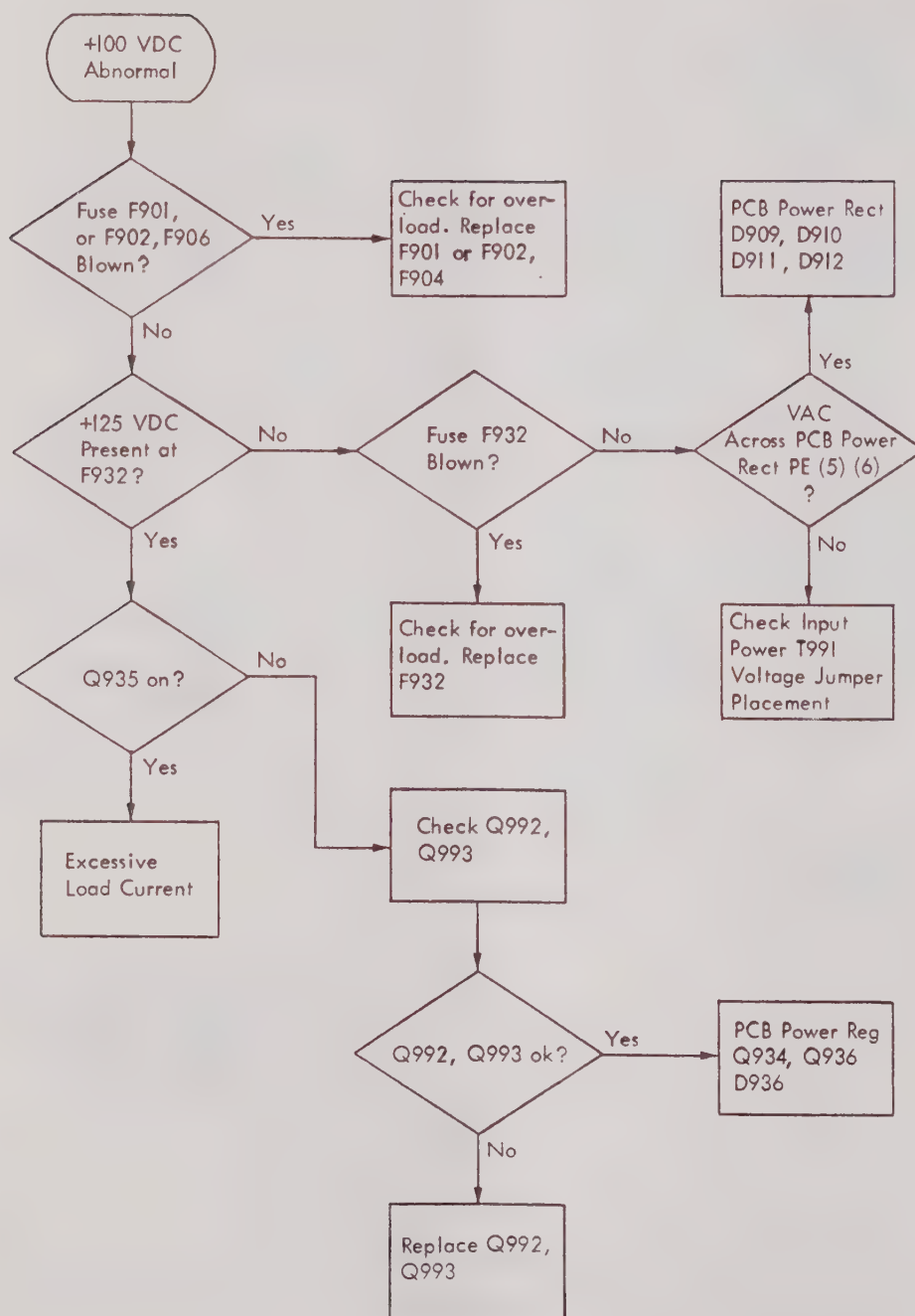


FIGURE 5-3.

Flow Chart, Fault Isolation, +100 VDC Abnormal (3)

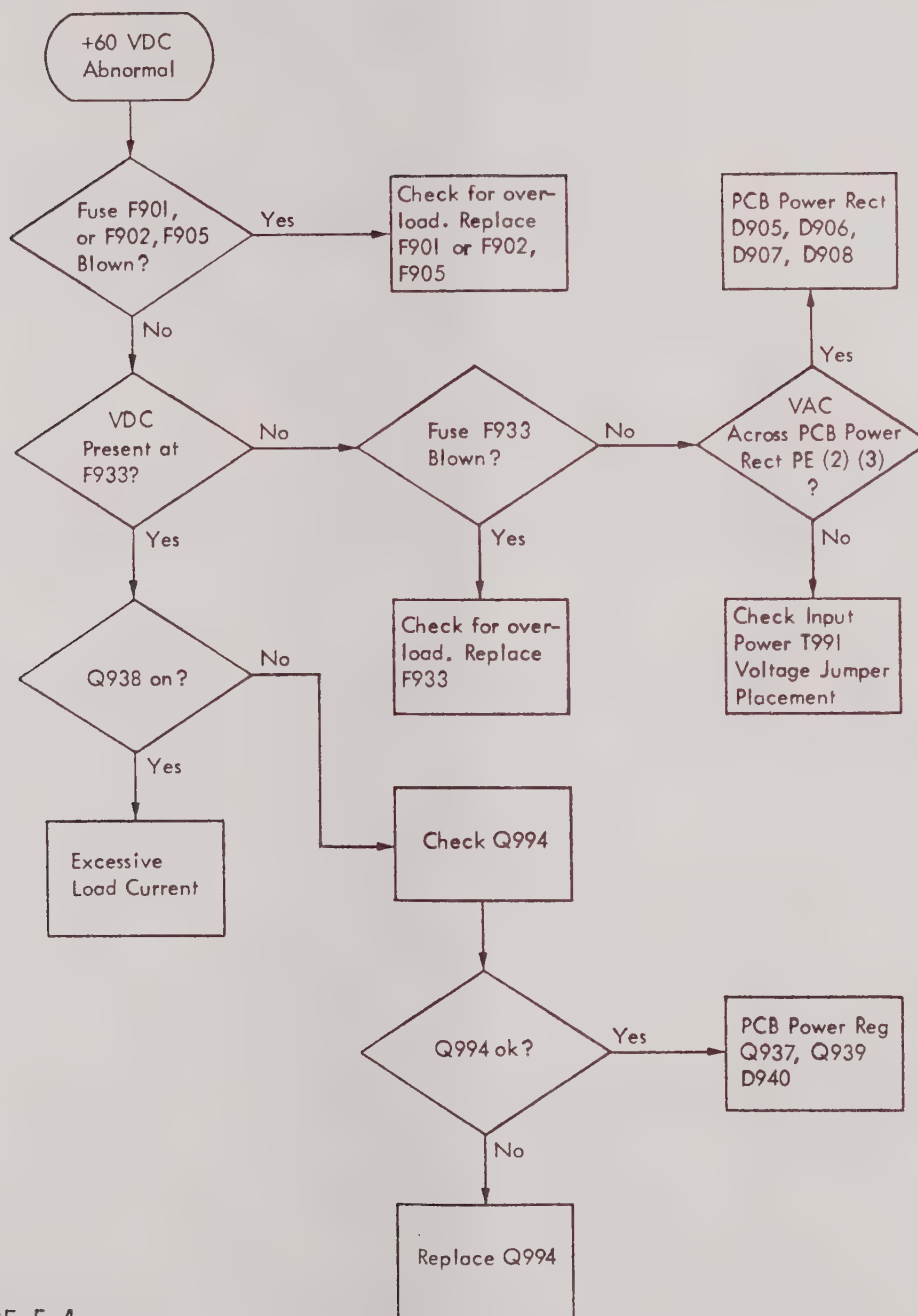


FIGURE 5-4.

Flow Chart, Fault Isolation, +60 VDC Abnormal (4)

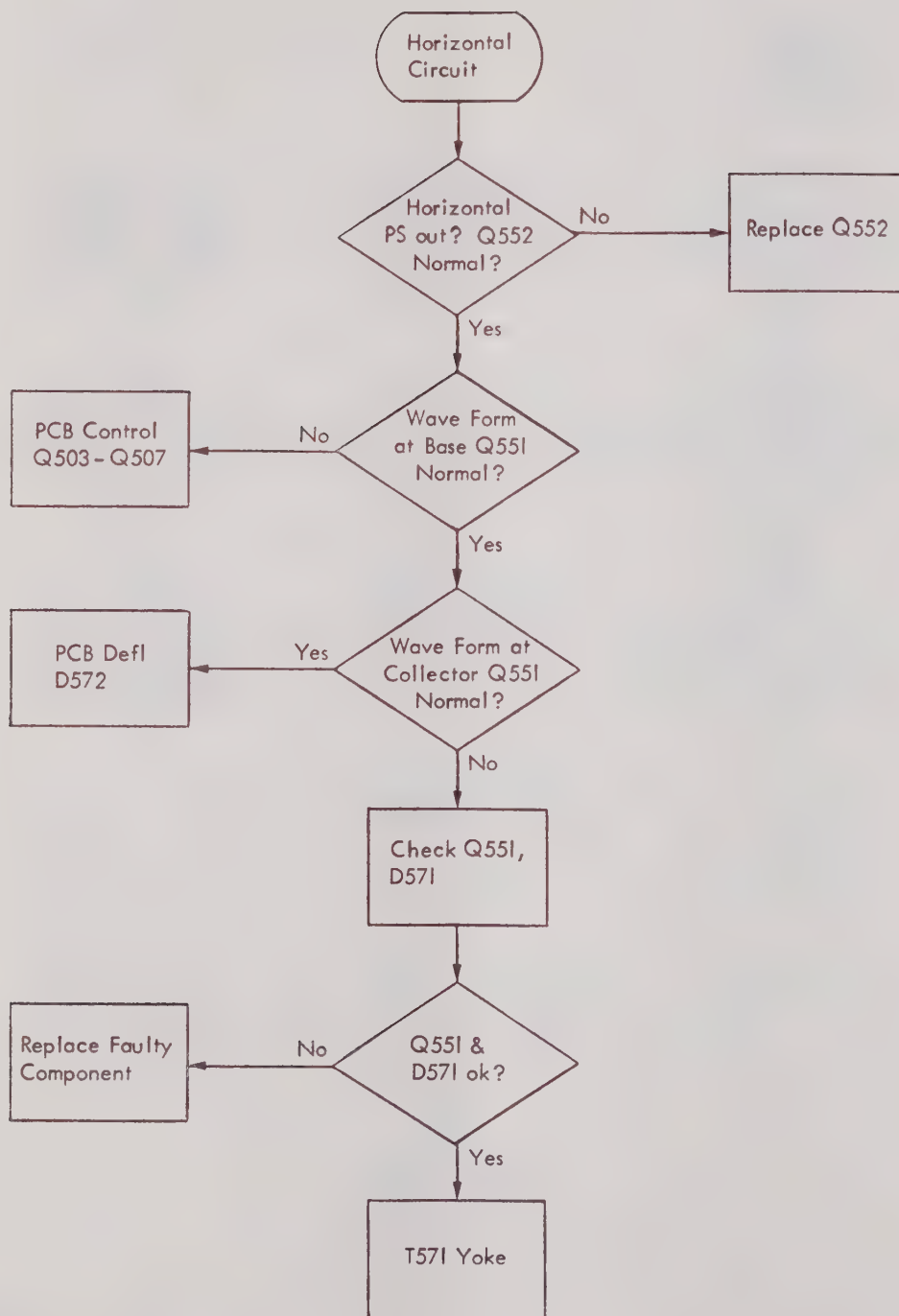


FIGURE 5-5.

Flow Chart, Fault Isolation, Horizontal Circuit (5)

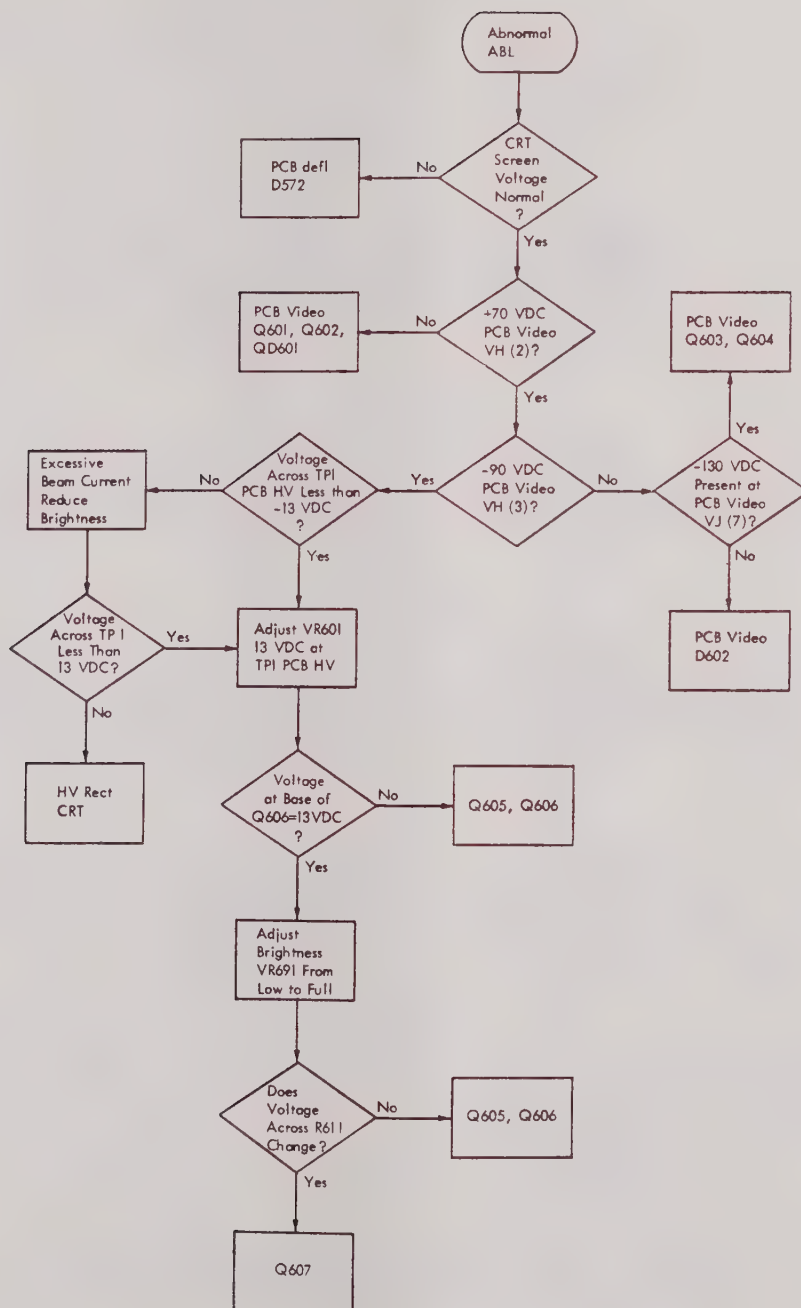


FIGURE 5-6.

Flow Chart, Fault Isolation, Abnormal ABL (6)

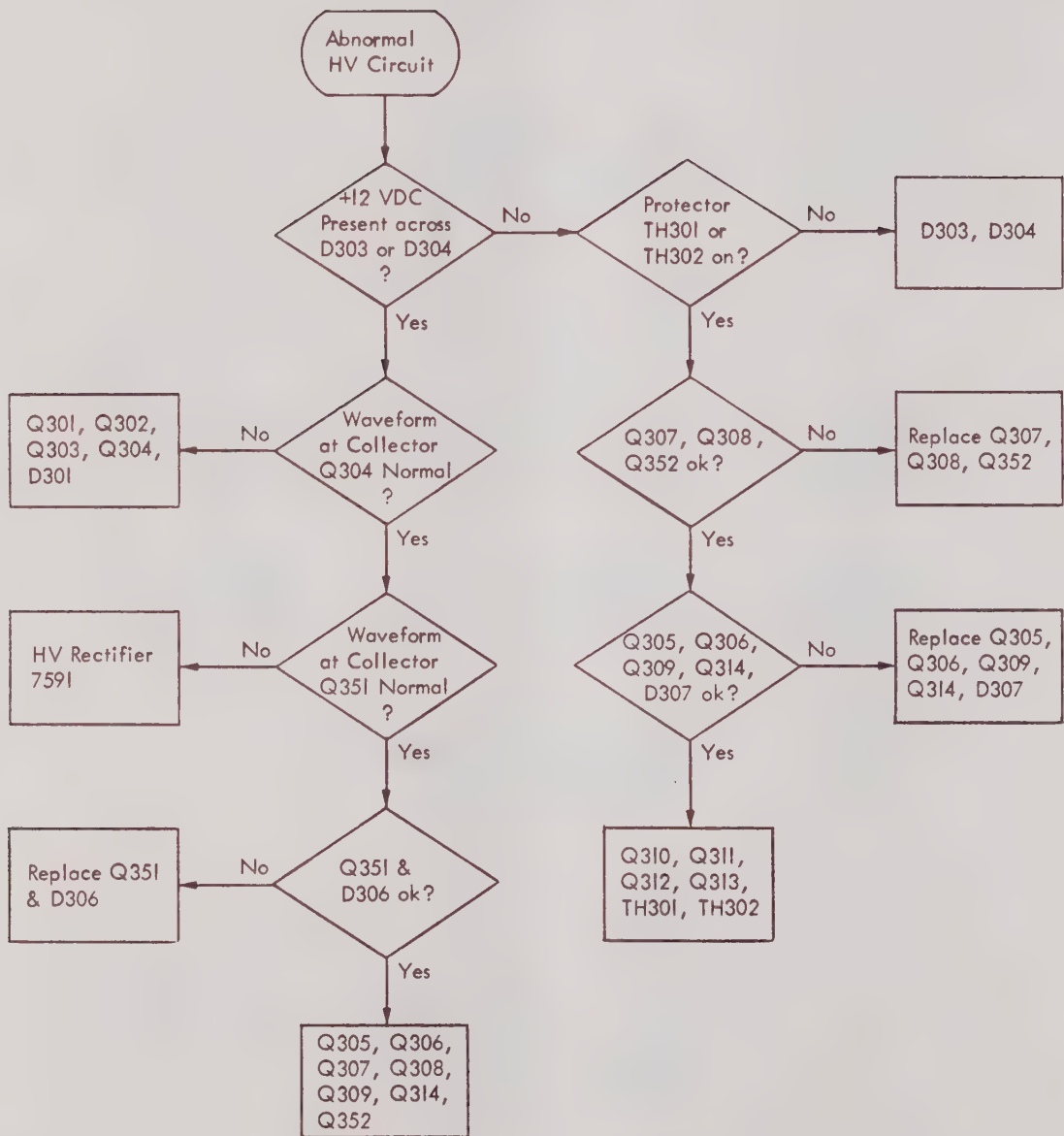


FIGURE 5-7.

Flow Chart, Fault Isolation, Abnormal HV Circuit (7)

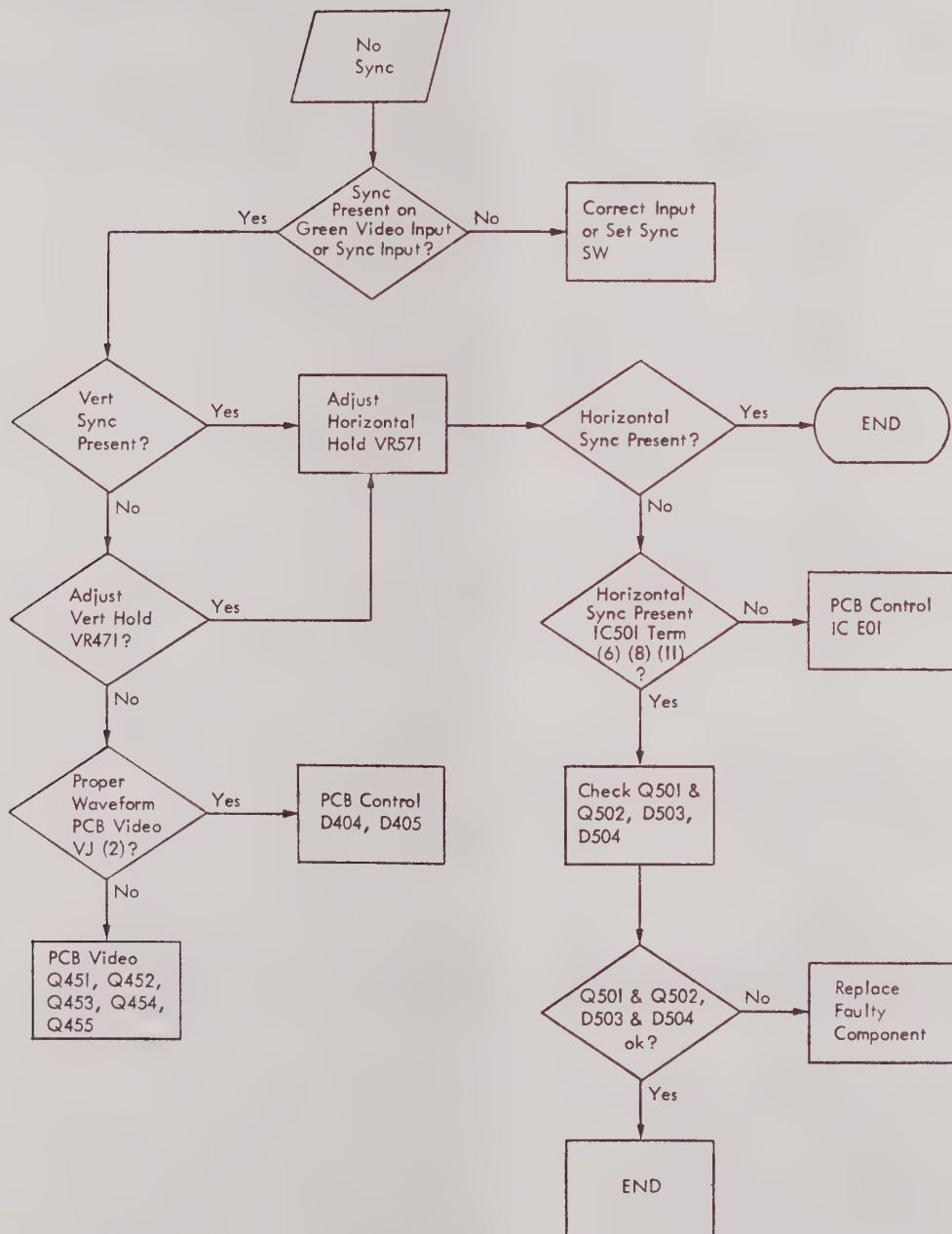
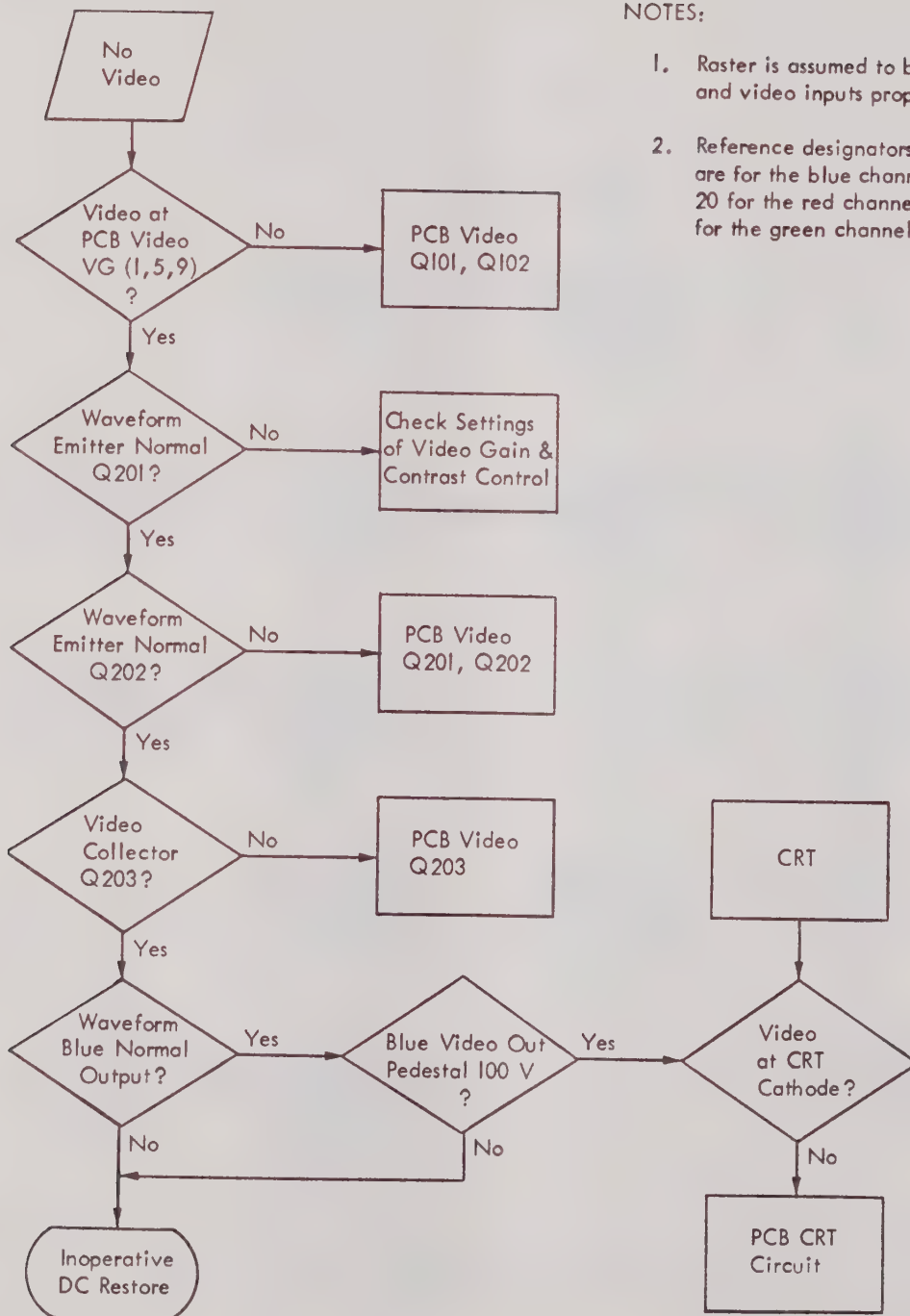


FIGURE 5-8.

Flow Chart, Fault Isolation, No Sync (8)

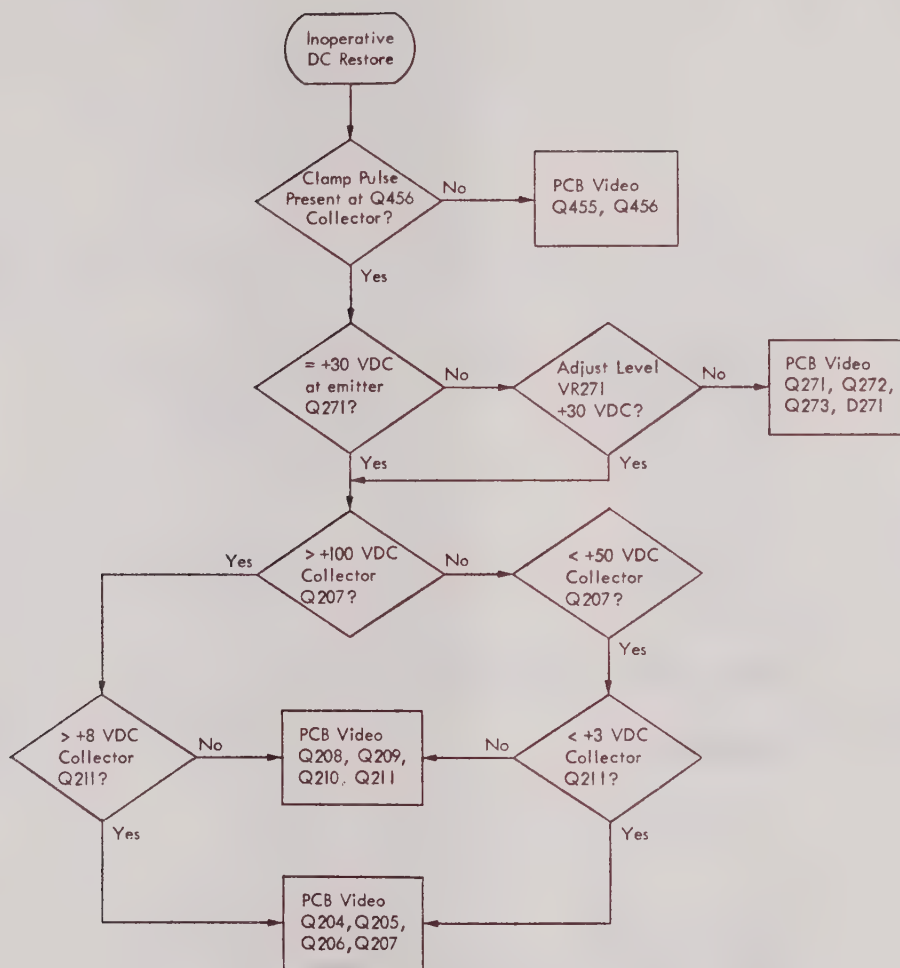


NOTES:

1. Raster is assumed to be visible and video inputs proper.
2. Reference designators shown are for the blue channel. Add 20 for the red channel and 40 for the green channel.

FIGURE 5-9.

Flow Chart, Fault Isolation, No Video (9)



NOTES:

1. Raster is assumed to be visible and video inputs proper.
2. Reference designators shown are for the blue channel. Add 20 to the reference designator for the red channel and add 40 for the green channel, except for Q271, 2 and 3.

FIGURE 5-10.

Flow Chart, Fault Isolation, Inoperative DC Restore (10)

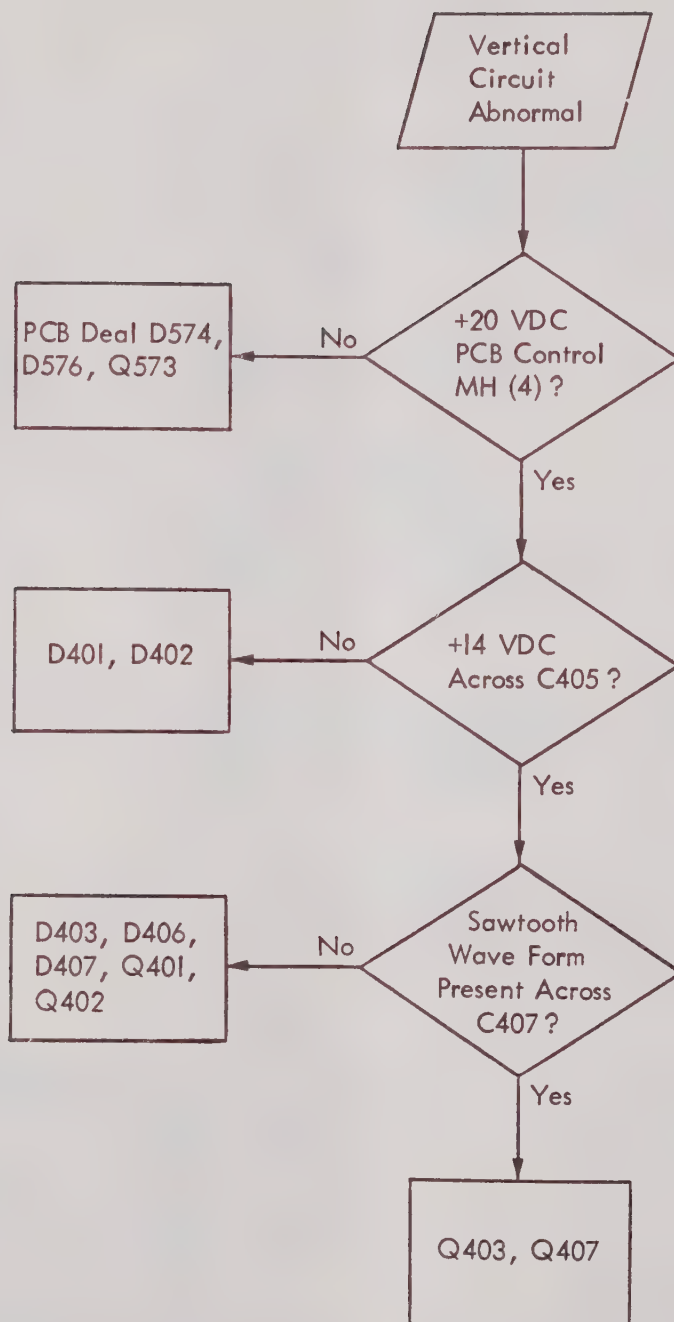


FIGURE 5-11.

Flow Chart, Fault Isolation, Vertical Circuit Abnormal (11)

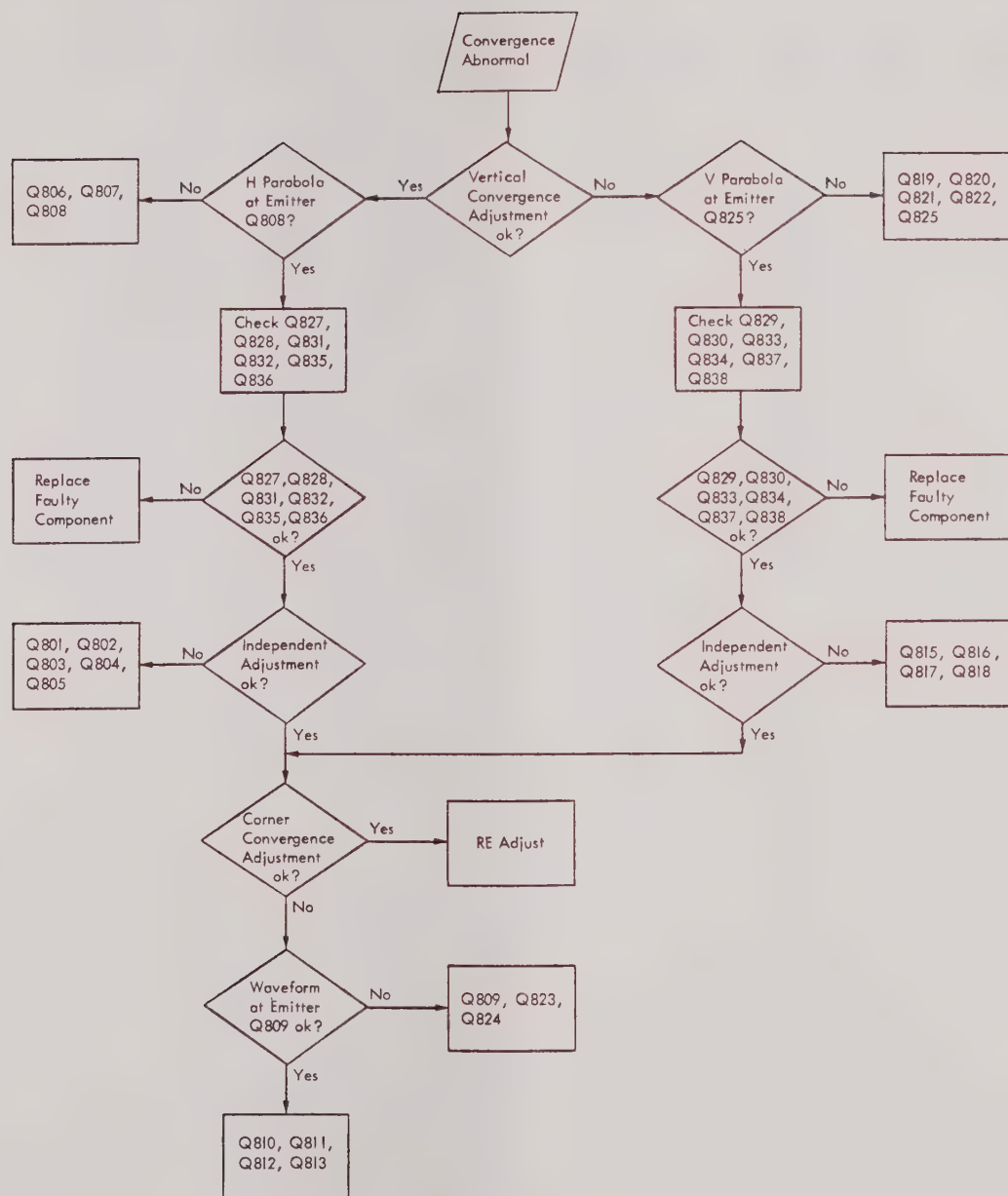


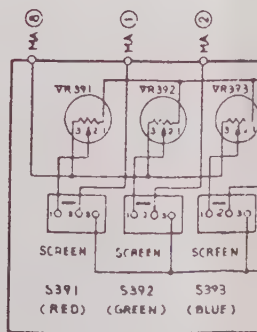
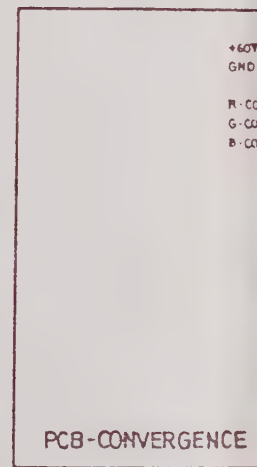
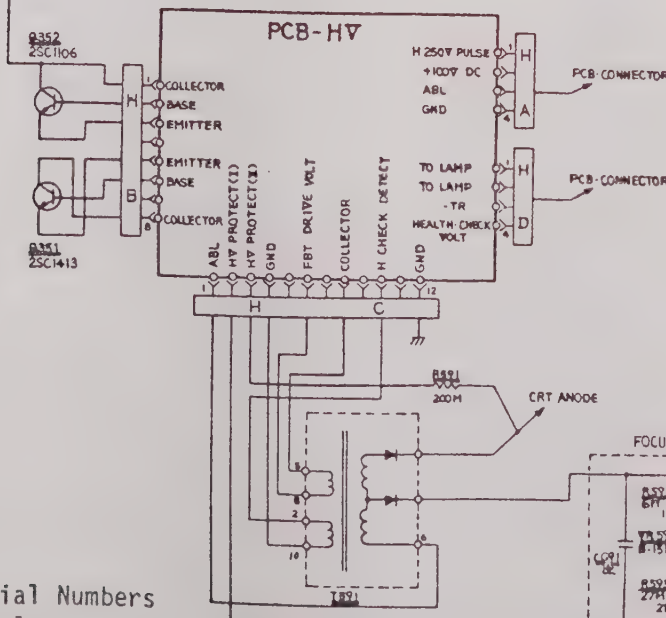
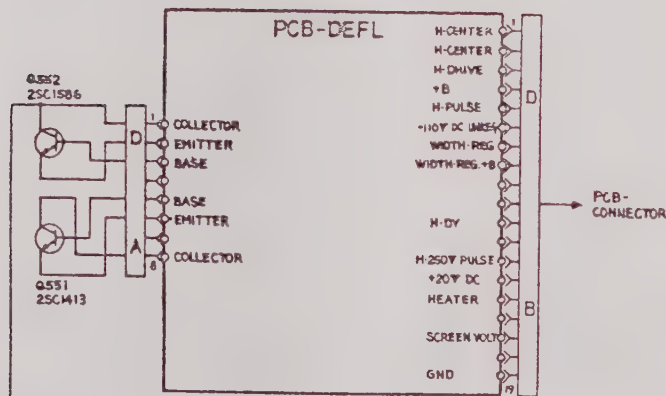
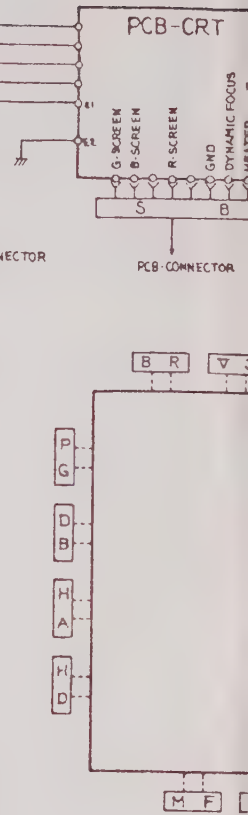
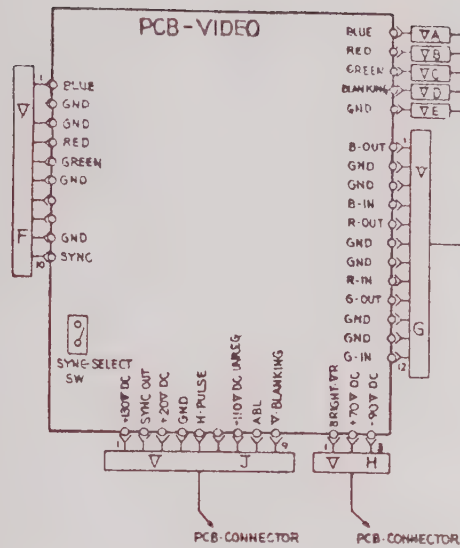
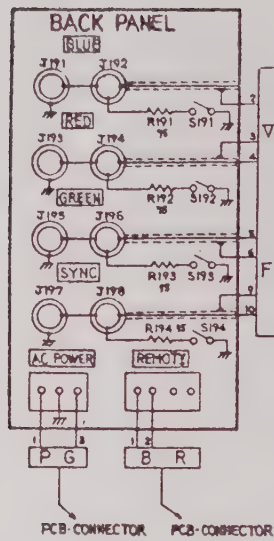
FIGURE 5-12.

Flow Chart, Fault Isolation, Convergence Abnormal (12)

6. SCHEMATIC DIAGRAMS

The following is a list of the Schematic Drawings that are included with this manual:

PCB-OVERVIEW, Figure 6-1 (1 of 2, 2 of 2)	Page 6-2, 6-3
PCB-CONNECTOR, Figure 6-2 (1 of 2, 2 of 2)	Page 6-4, 6-5
PCB-POWER-RECT, Figure 6-3	Page 6-6
PCB-POWER-REG, Figure 6-4	Page 6-7
PCB-HV, Figure 6-5	Page 6-8
PCB-CONVERGENCE, Figure 6-6 (1 of 2, 2 of 2)	Page 6-9, 6-10
PCB-CONTROL, Figure 6-7 (1 of 2, 2 of 2)	Page 6-11, 6-12
PCB-DEFL, Figure 6-8 (1 of 2, 2 of 2)	Page 6-13, 6-14
PCB-CRT, Figure 6-9 (1 of 2, 2 of 2)	Page 6-15, 6-16
PCB-VIDEO, Figure 6-10 (1 of 2, 2 of 2)	Page 6-17, 6-18



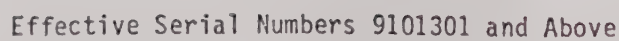
Effective Serial Numbers
9101300 and Below

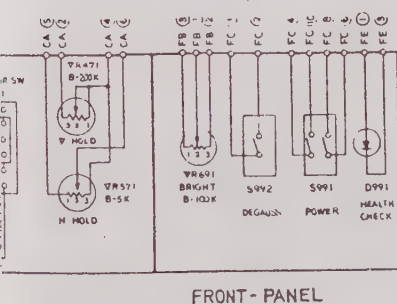


Underlined components have special characteristics important to safety and performance. Therefore replacement of any safety parts should be identical in value and characteristics.

Don't degrade the safety of the monitor through improper servicing.

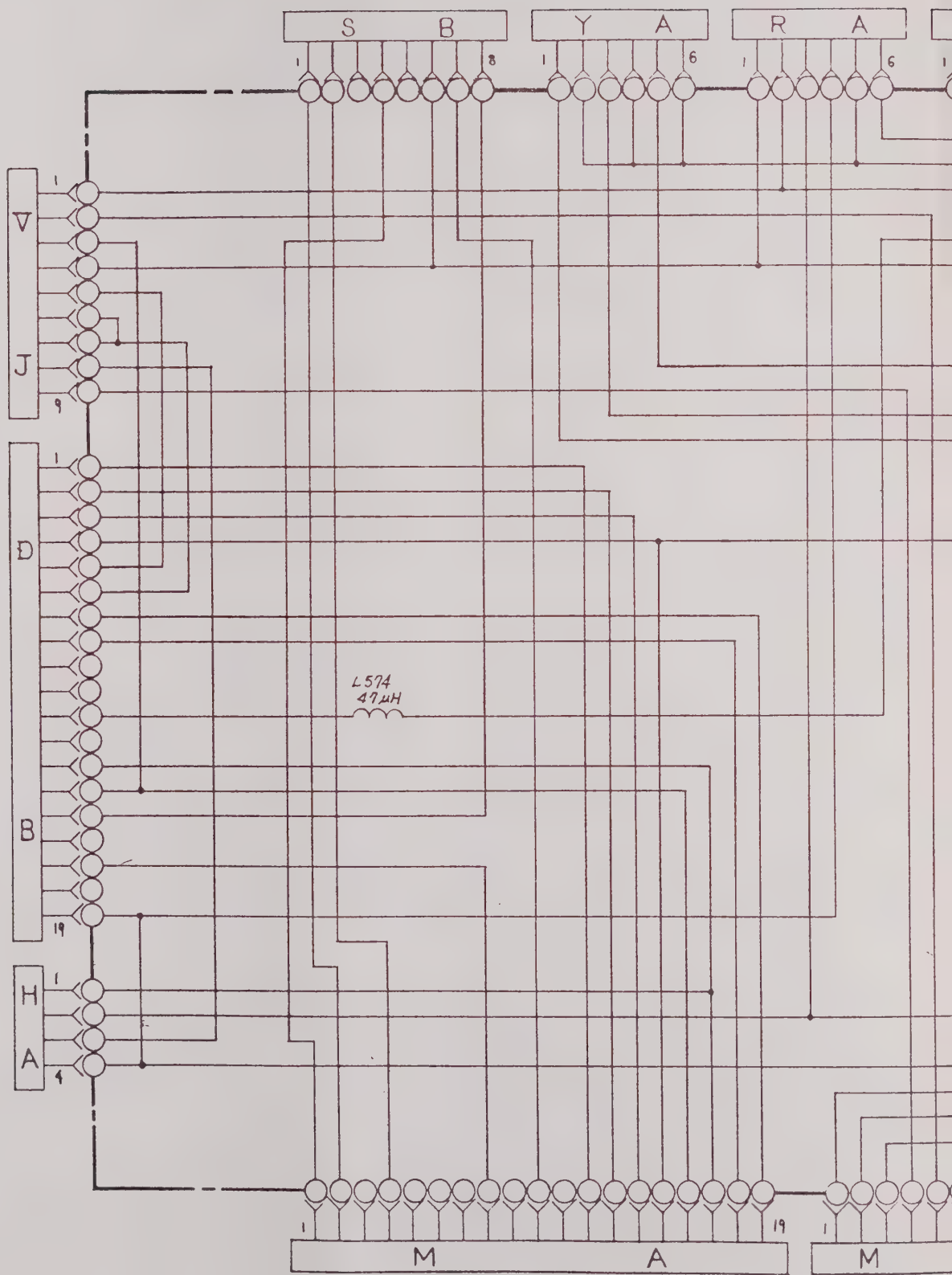






SERVICING PRECAUTION
UNDERLINED COMPONENTS HAVE SPECIAL
CHARACTERISTICS IMPOTANT TO SAFE-
TY AND PERFORMANCE.THEREFORE RE-
PLACEMENT OF ANY SAFETY PARTS
SHOULD BE IDENTICAL IN VALUE AND
CHARACTERISTICS.
DONT DEGRADE THE SAFETY OF THE
MONITOR THROUGH IMPROPER SERVICING.

Figure 6-1. PCB Overview
(Sheet 2 of 2)



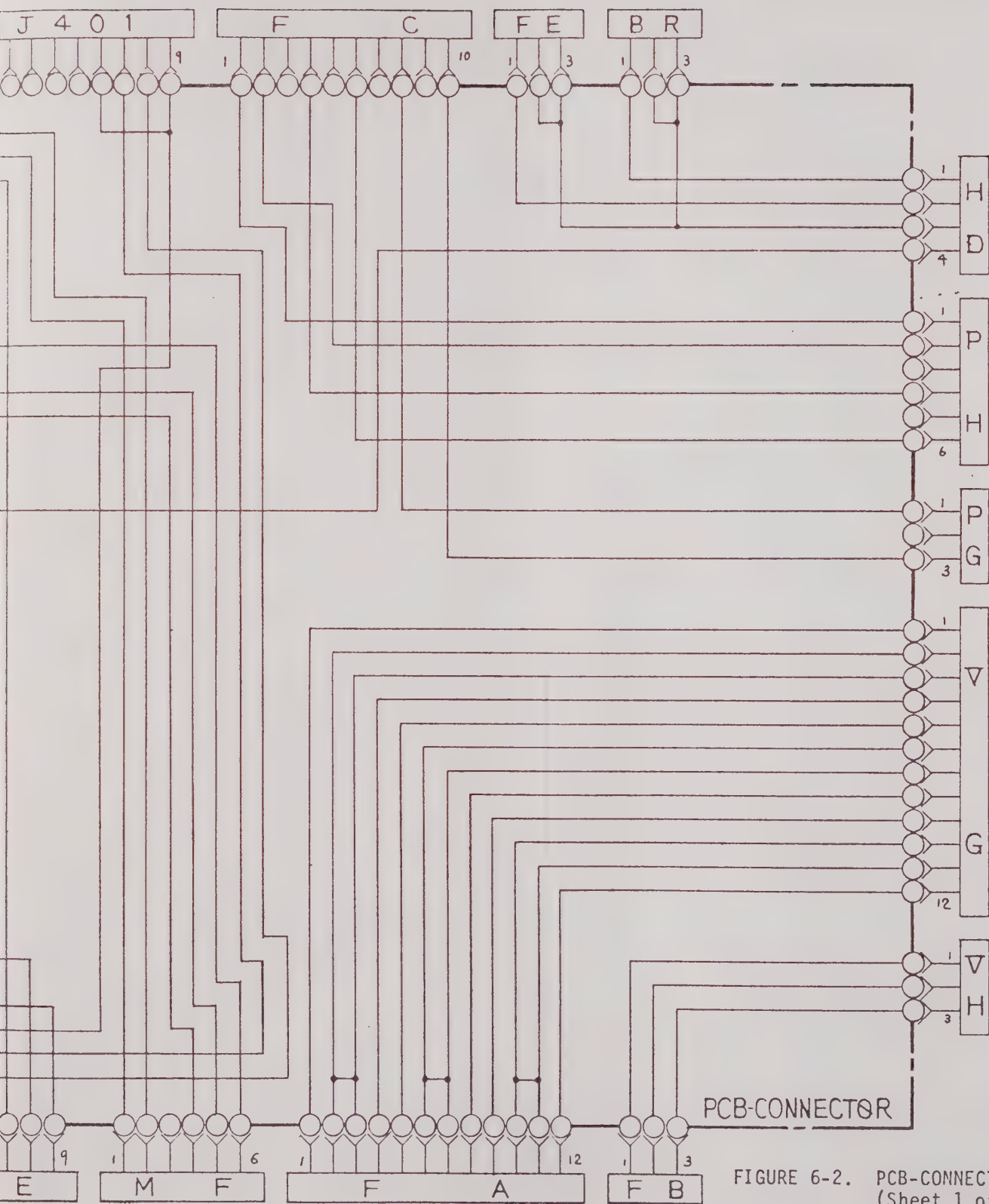
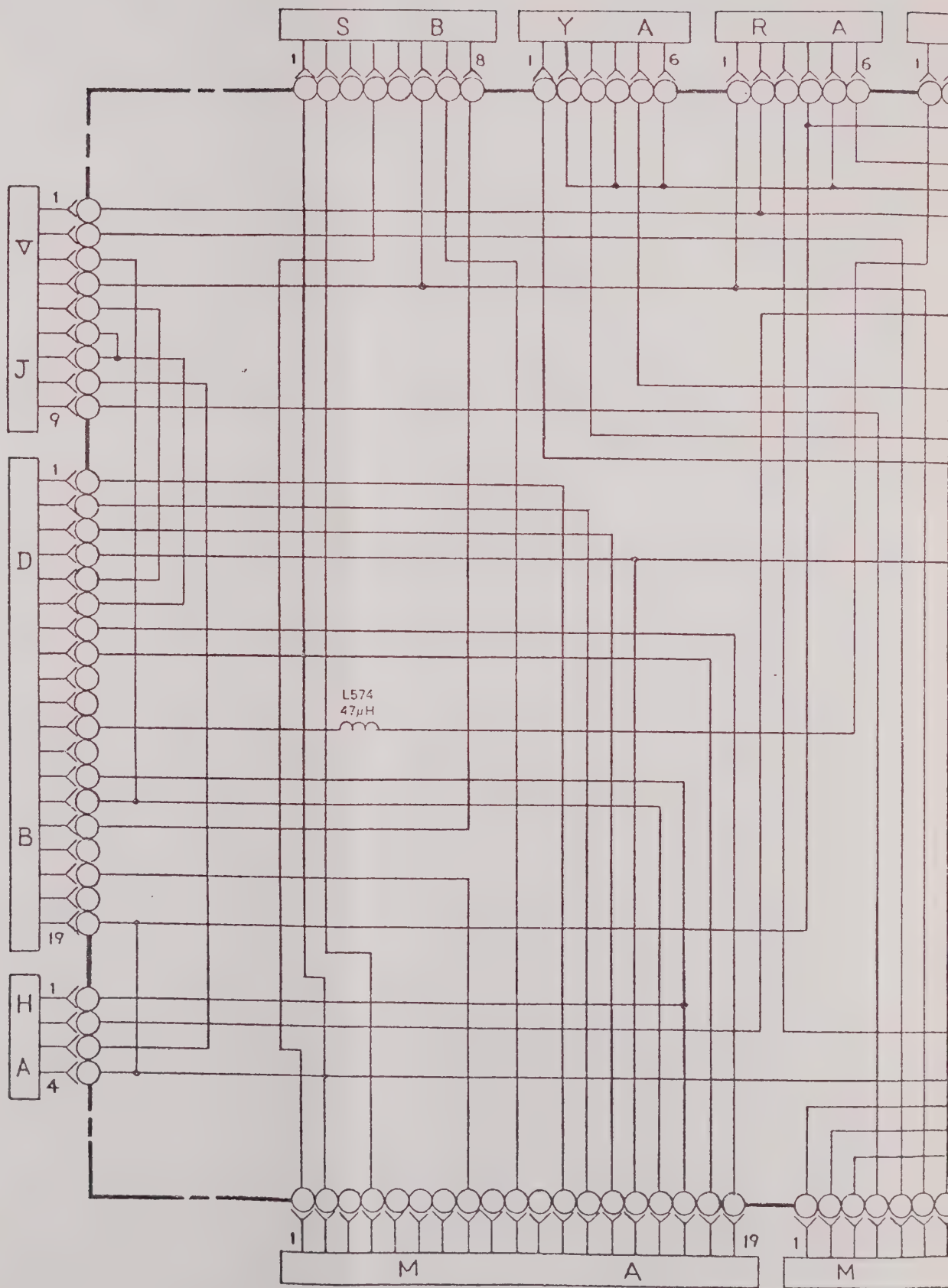


FIGURE 6-2. PCB-CONNECTOR
(Sheet 1 of 2)



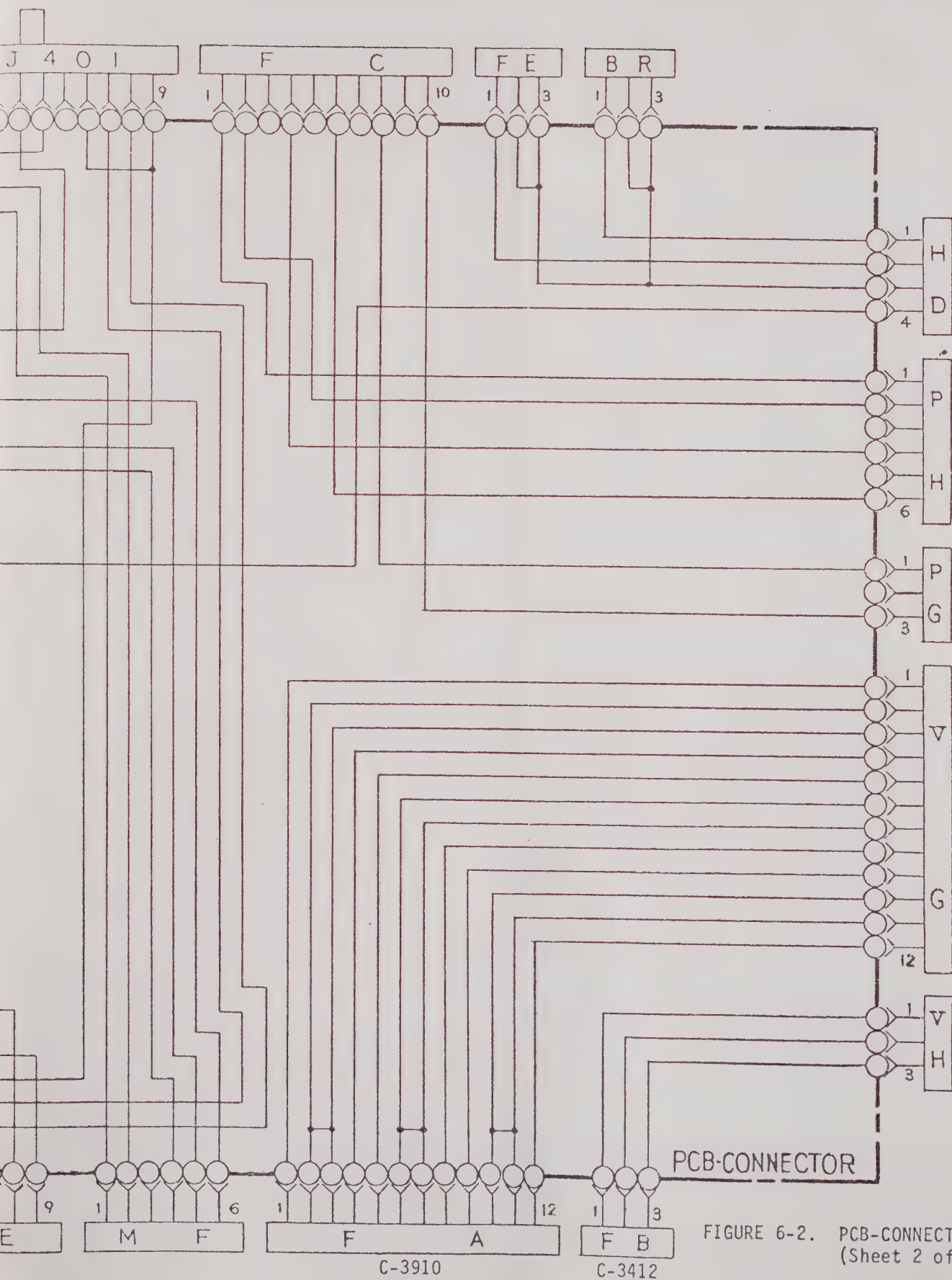
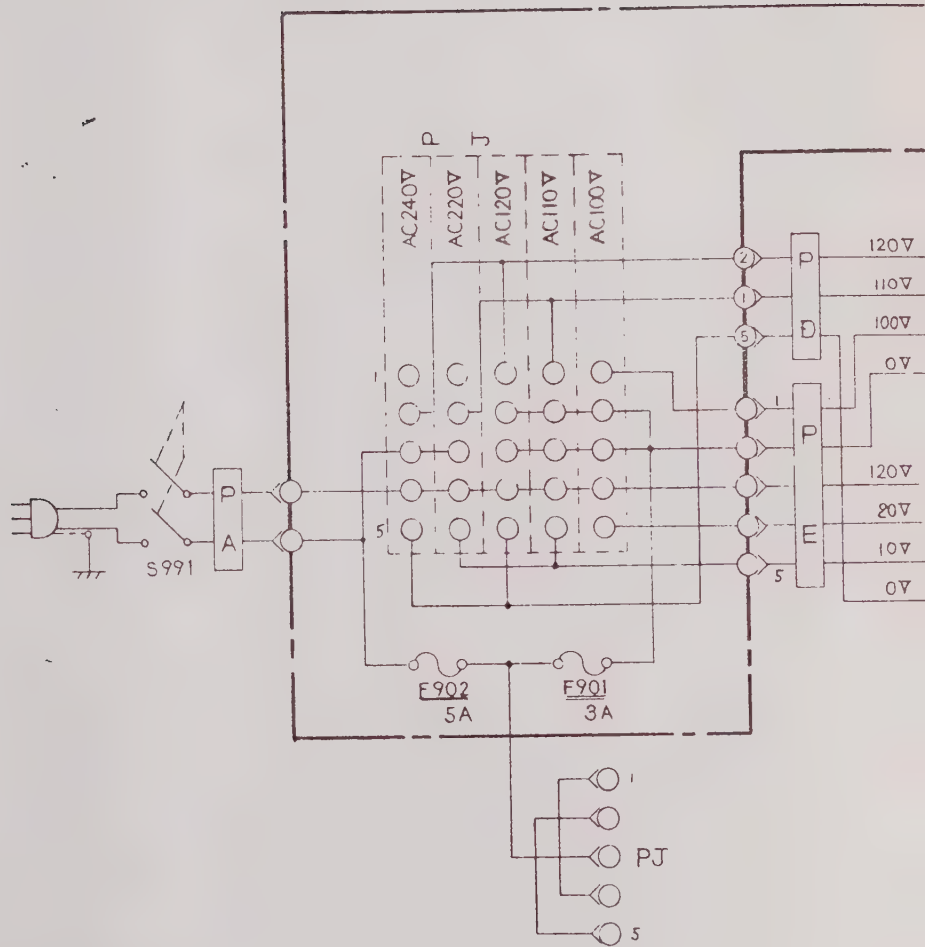


FIGURE 6-2. PCB-CONNECTOR
(Sheet 2 of 2)



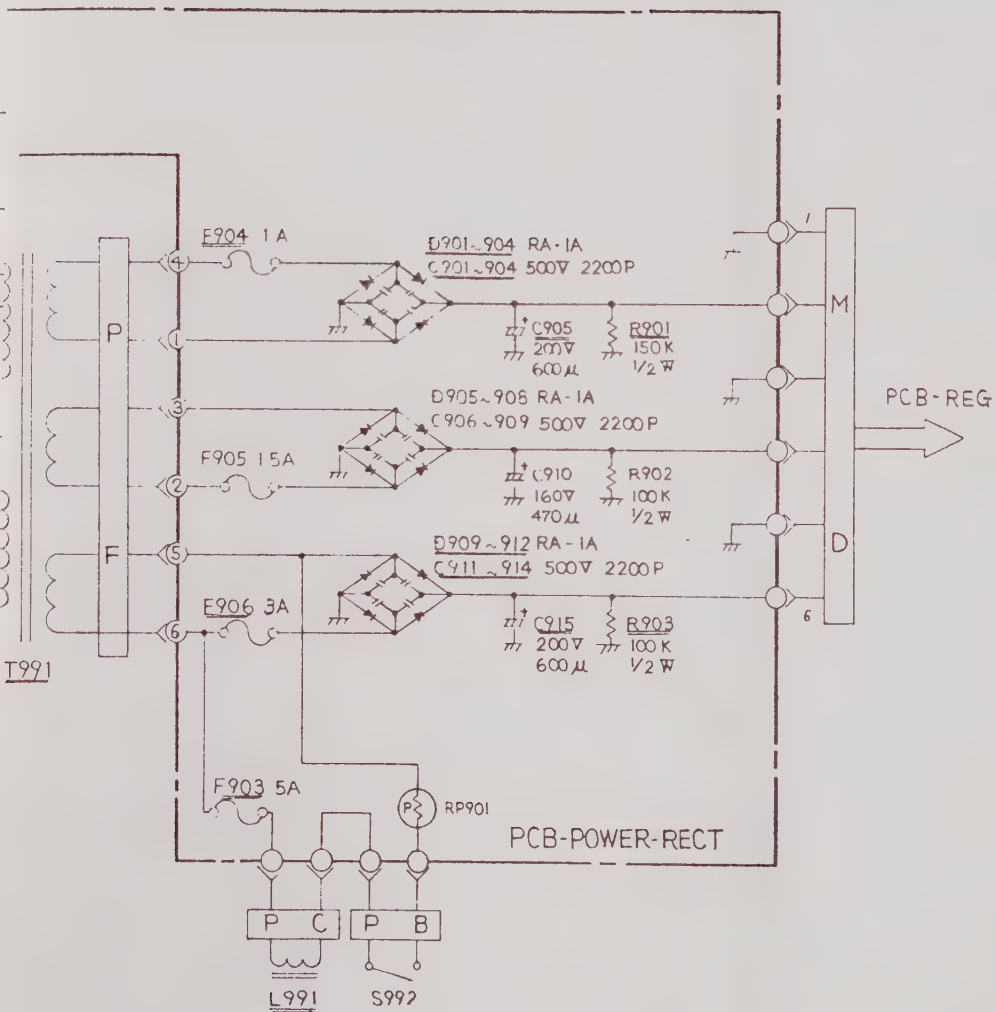


FIGURE 6-3. PCB-POWER-RECT

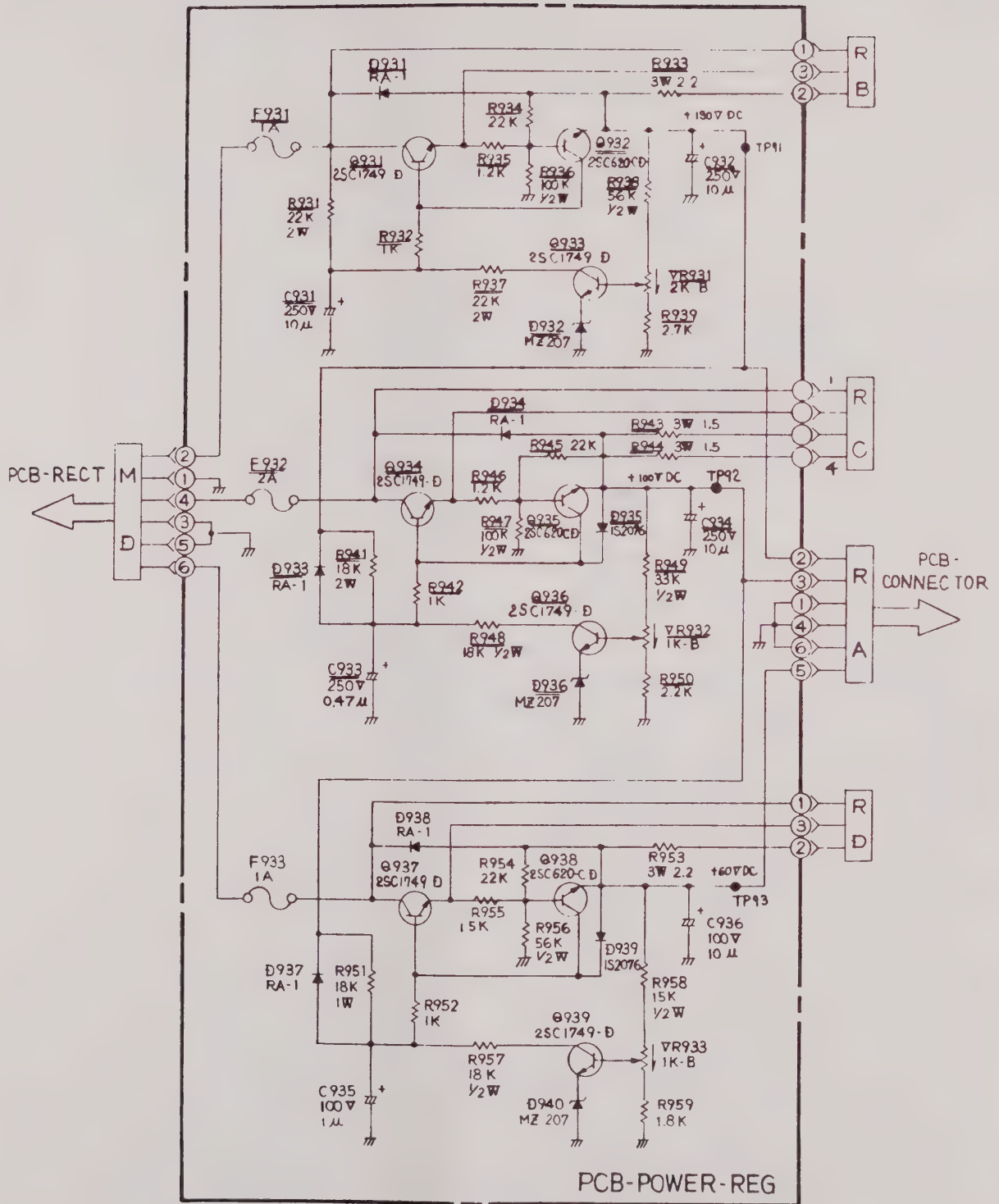
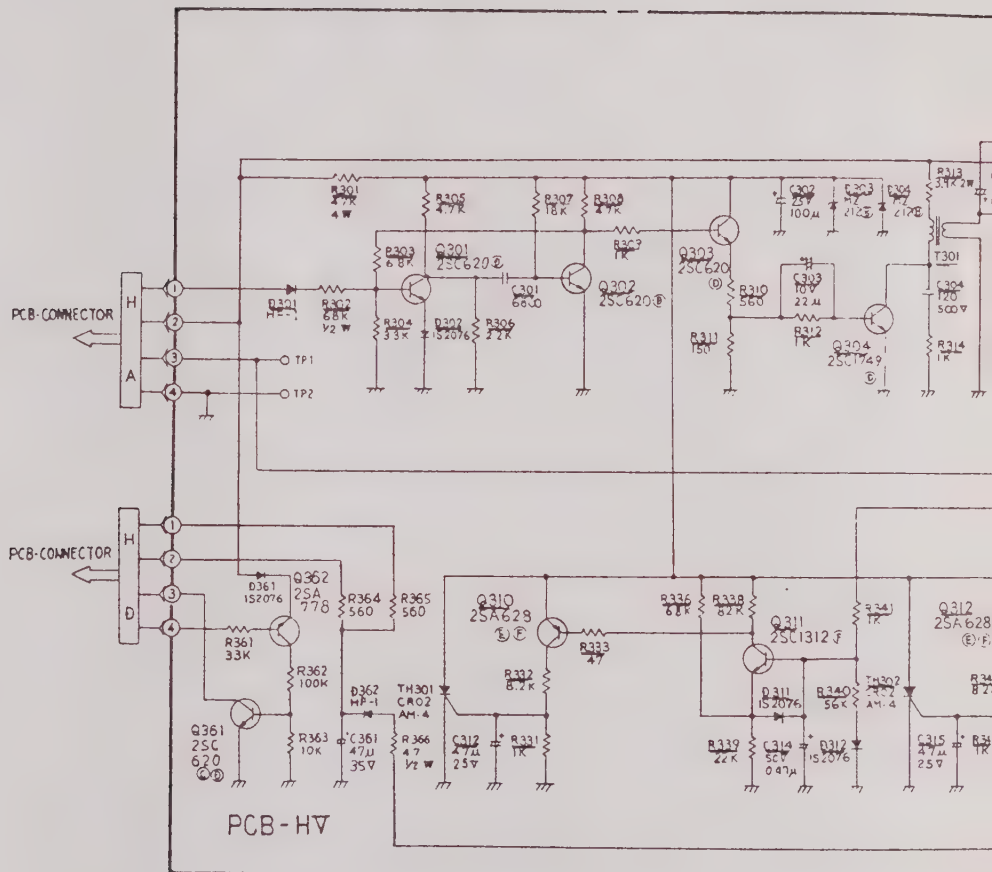


FIGURE 6-4. PCB-POWER-REG



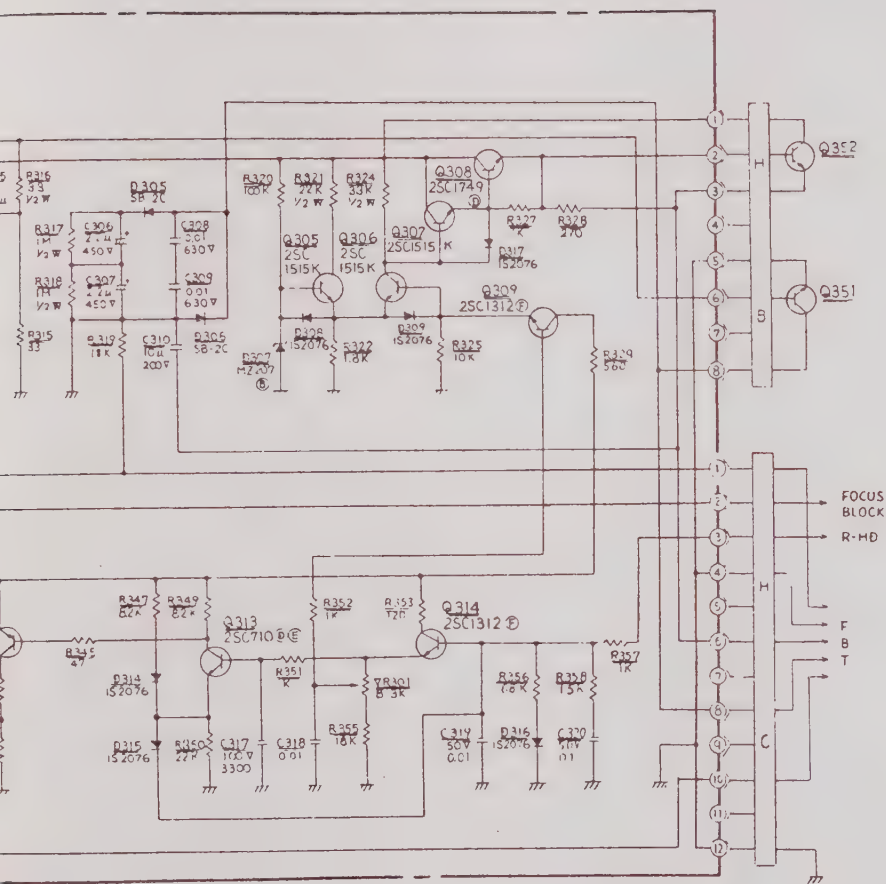
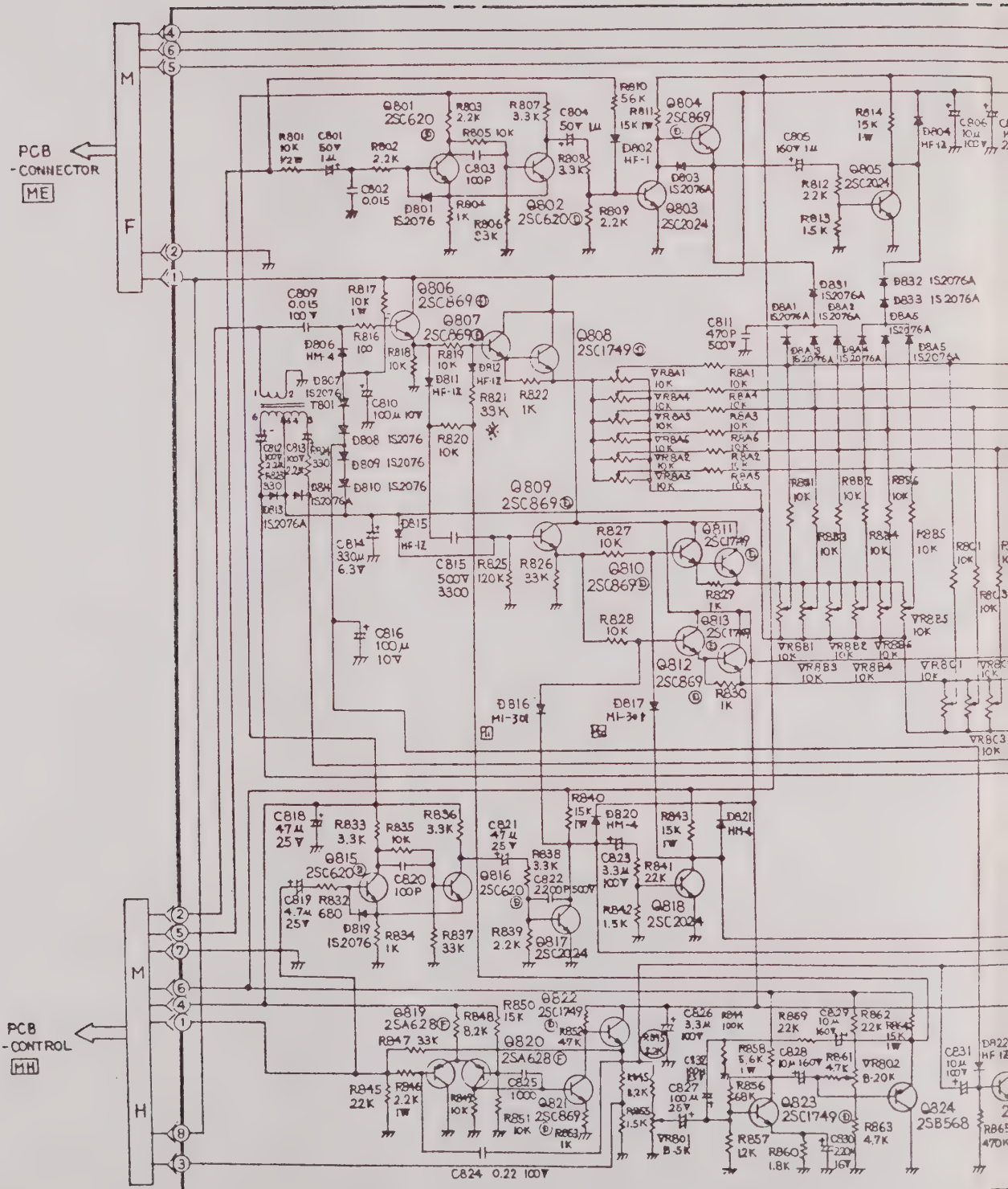


FIGURE 6-5. PCB-HV



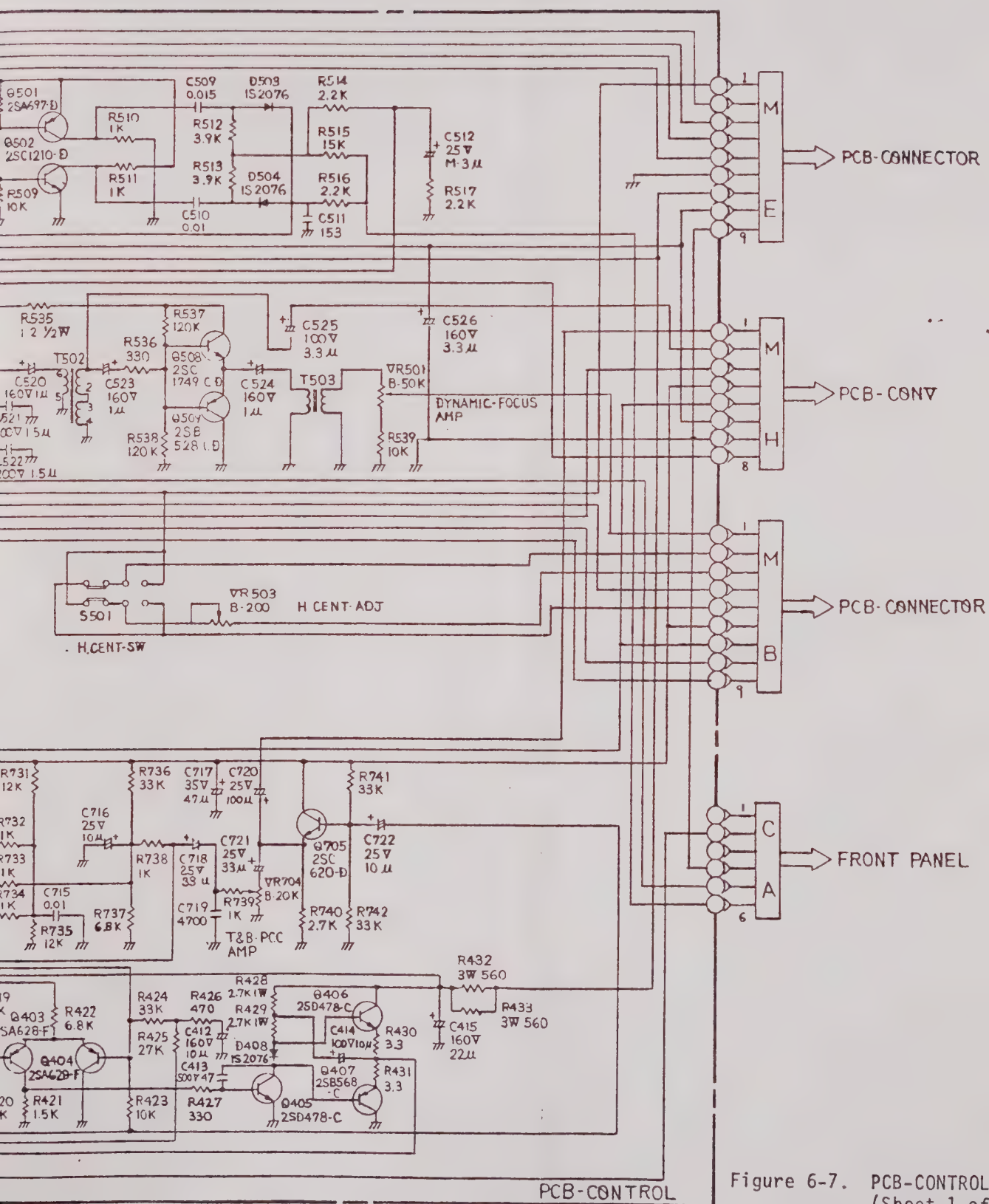
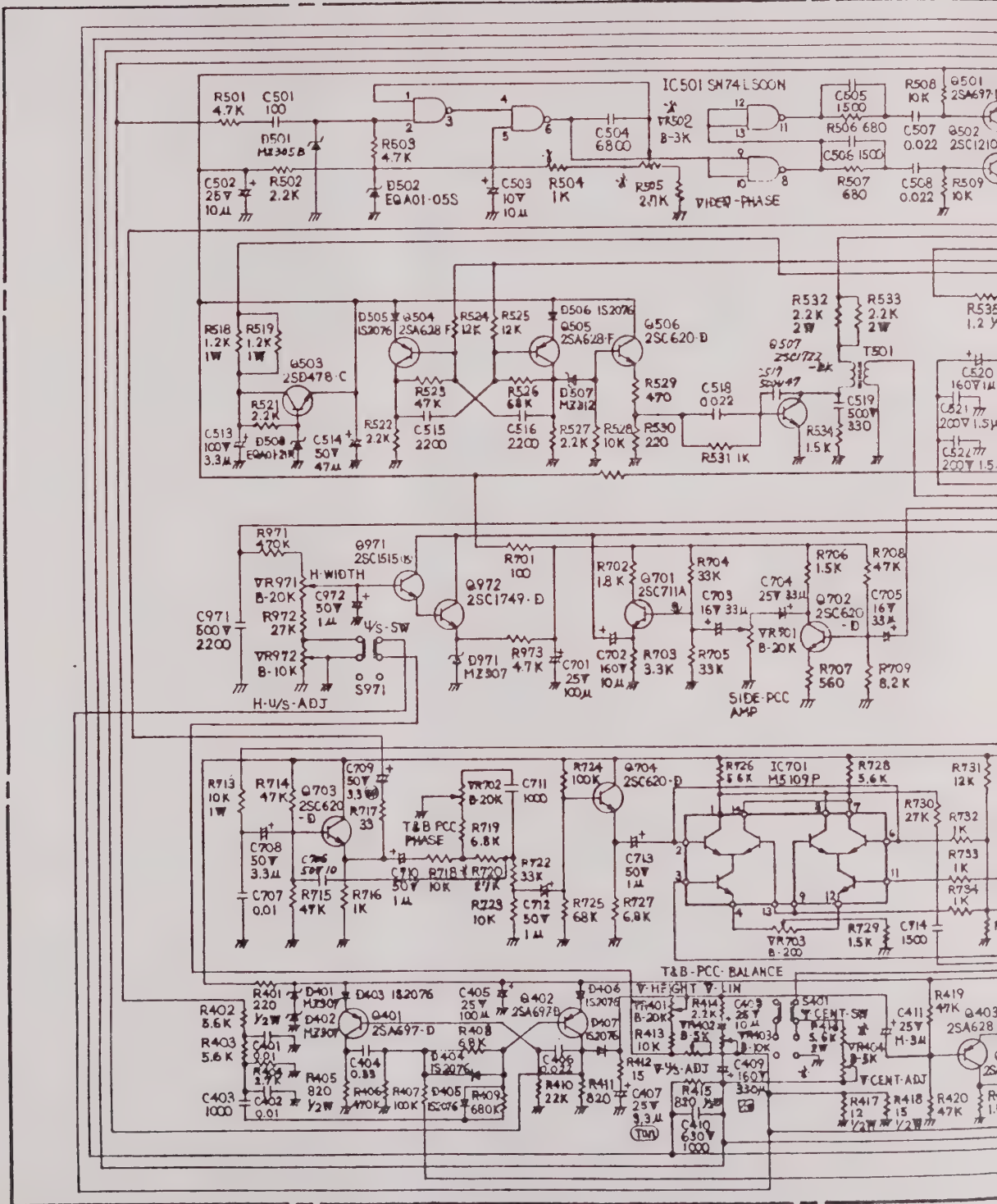


Figure 6-7. PCB-CONTROL
(Sheet 1 of 2)



Effective Serial Numbers 9101301 and Above

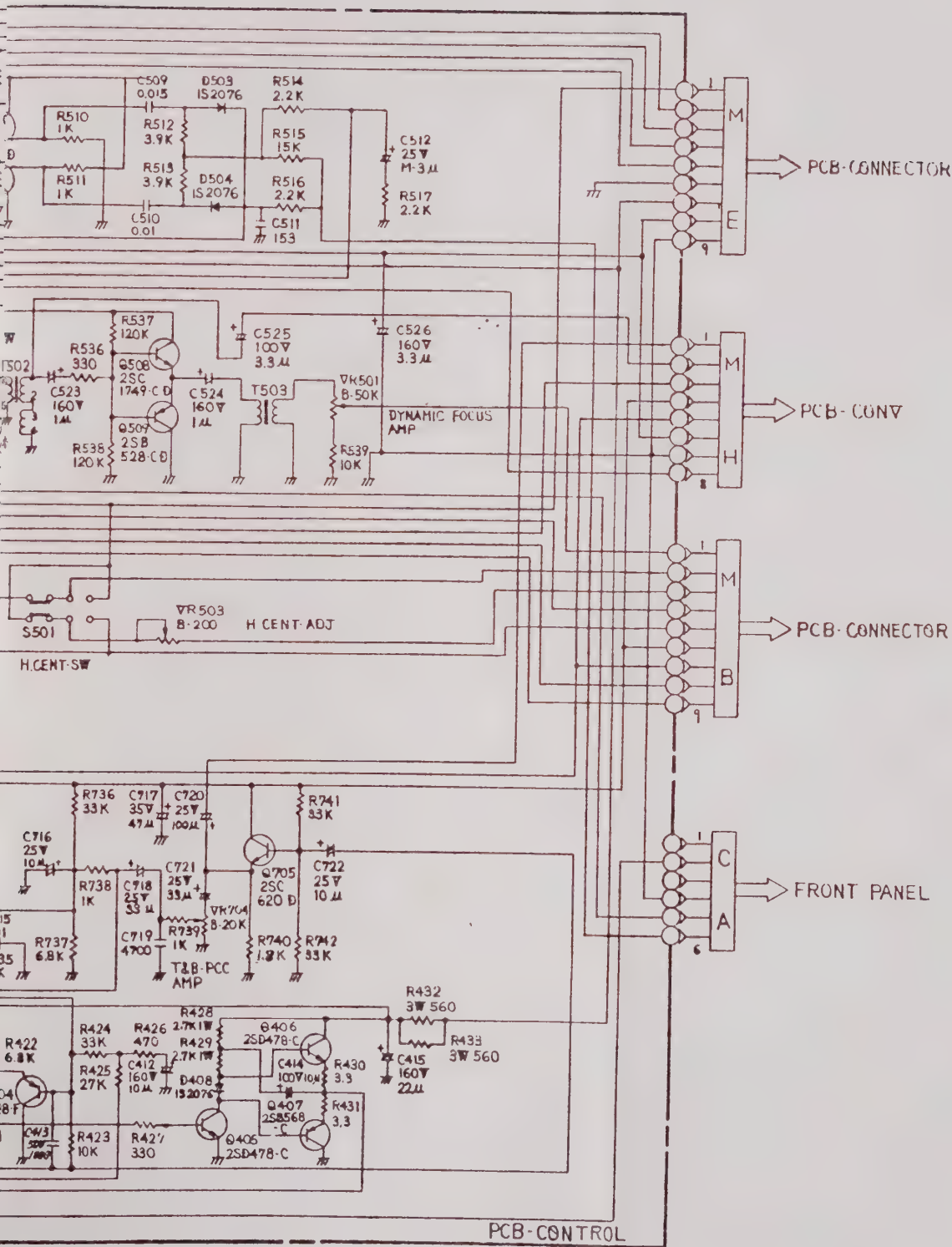
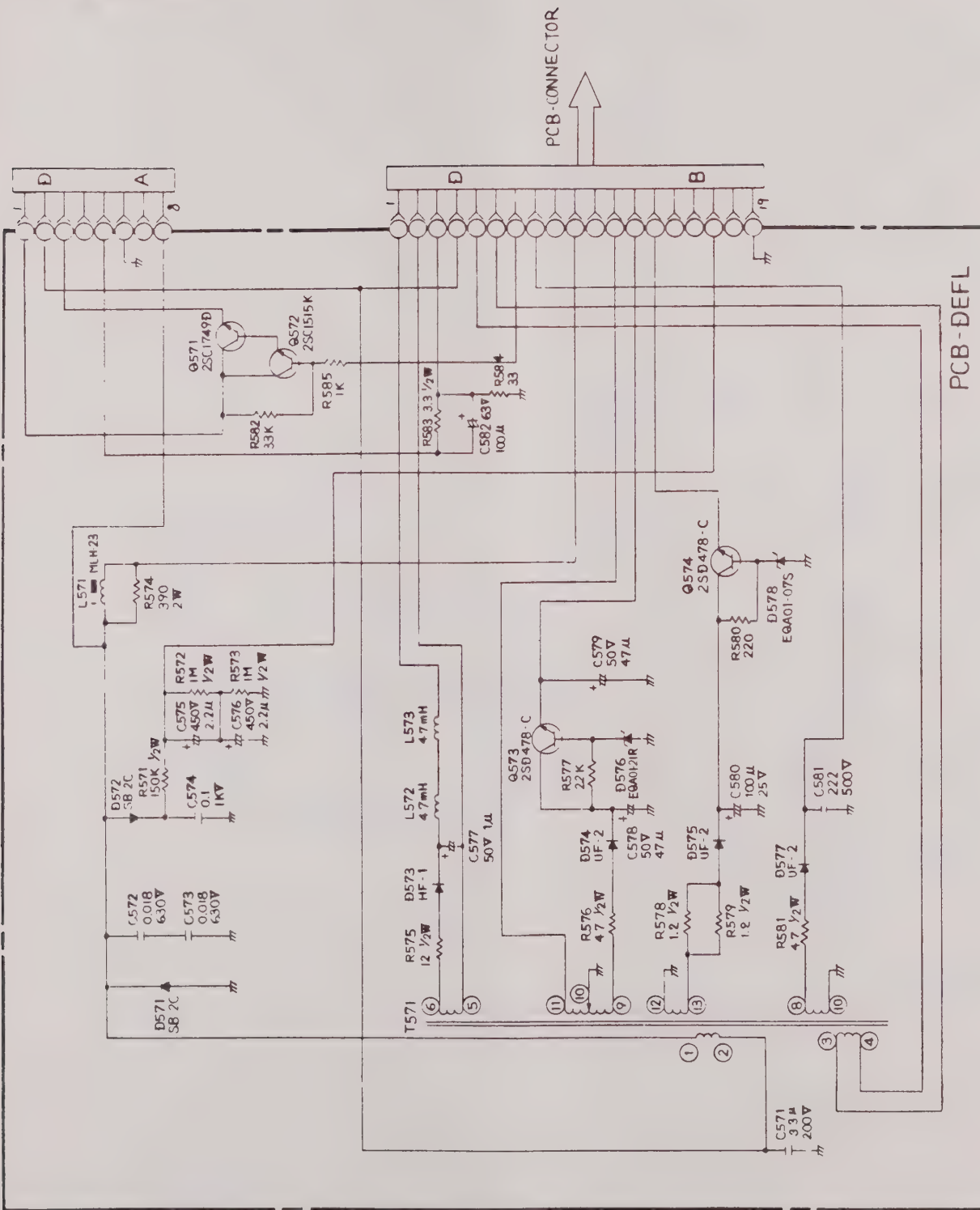
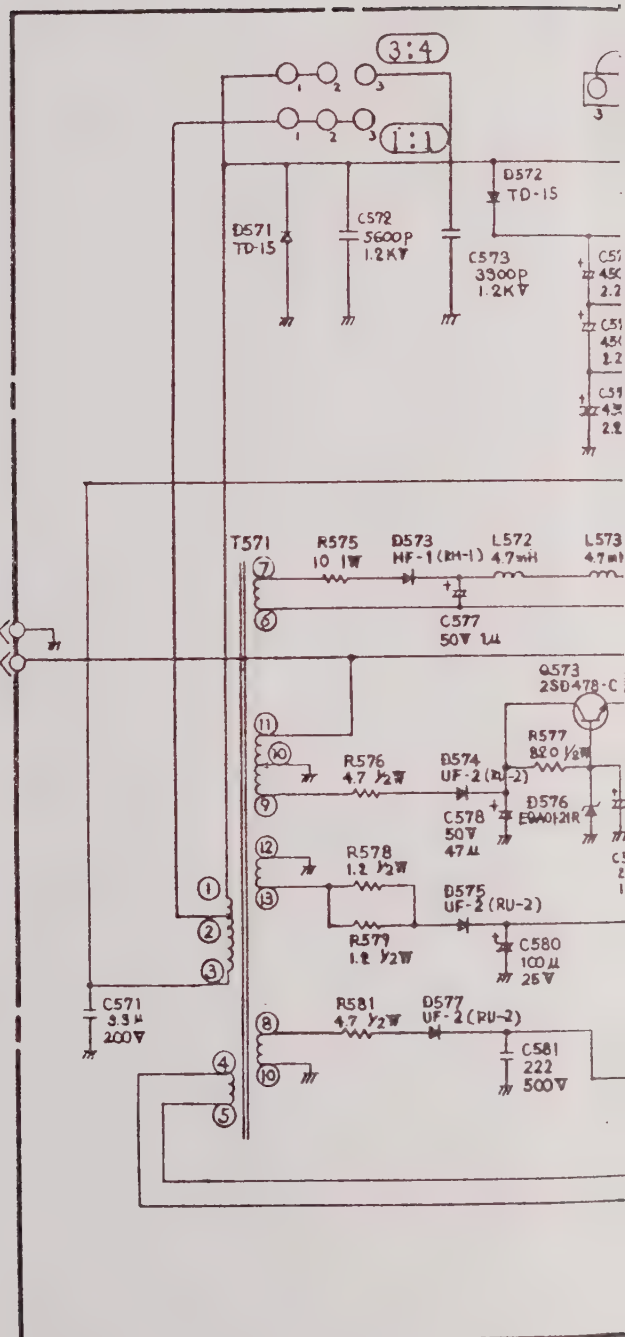
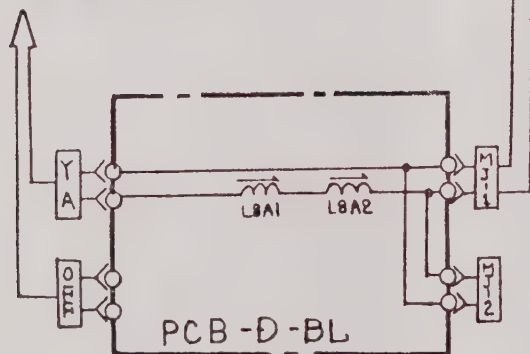


Figure 6-7. PCB-CONTROL
(Sheet 2 of 2)



Effective Serial Numbers 9101300 and Below

Figure 6-8. PCB-DEFL (Sheet 1 of 2)



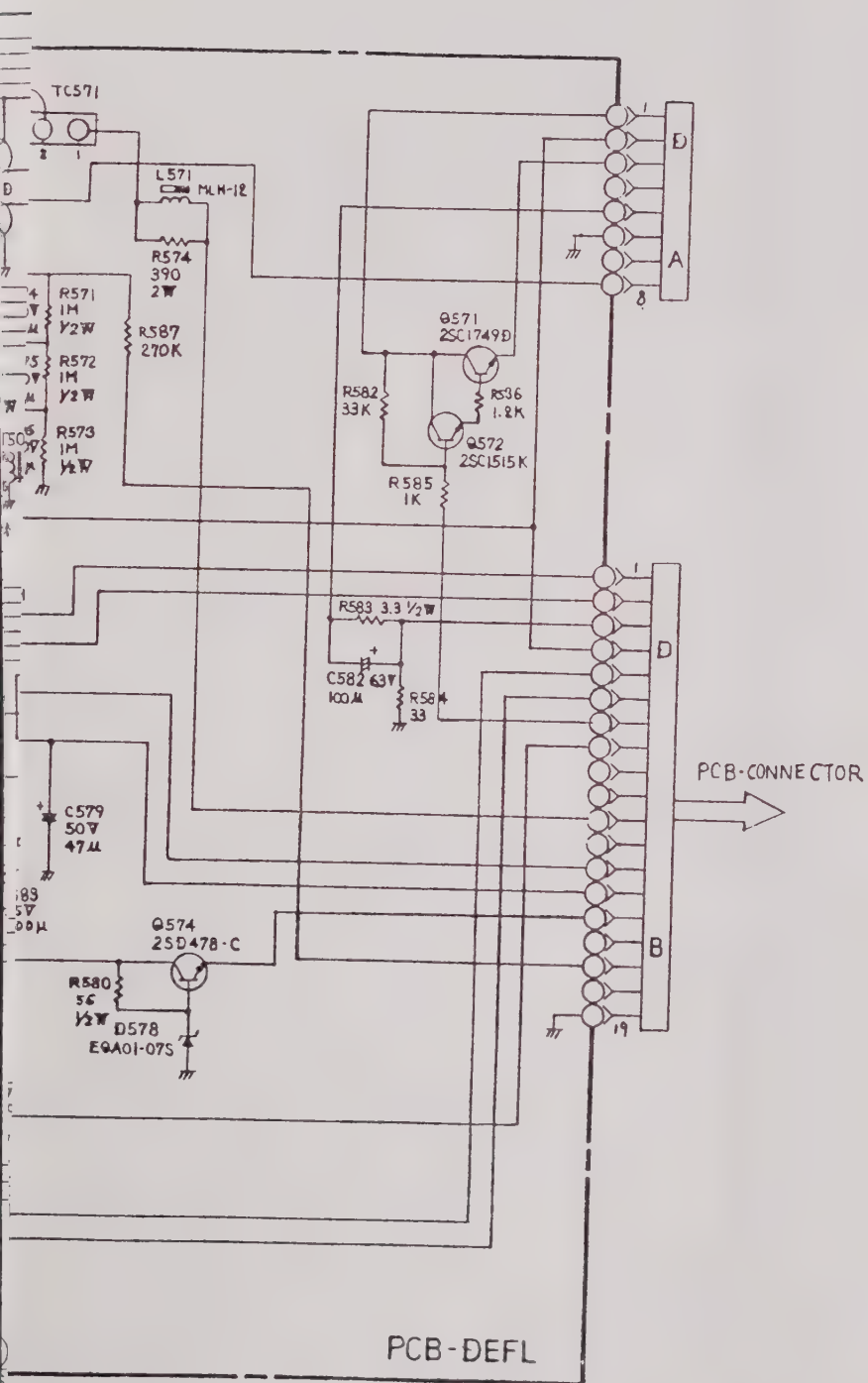
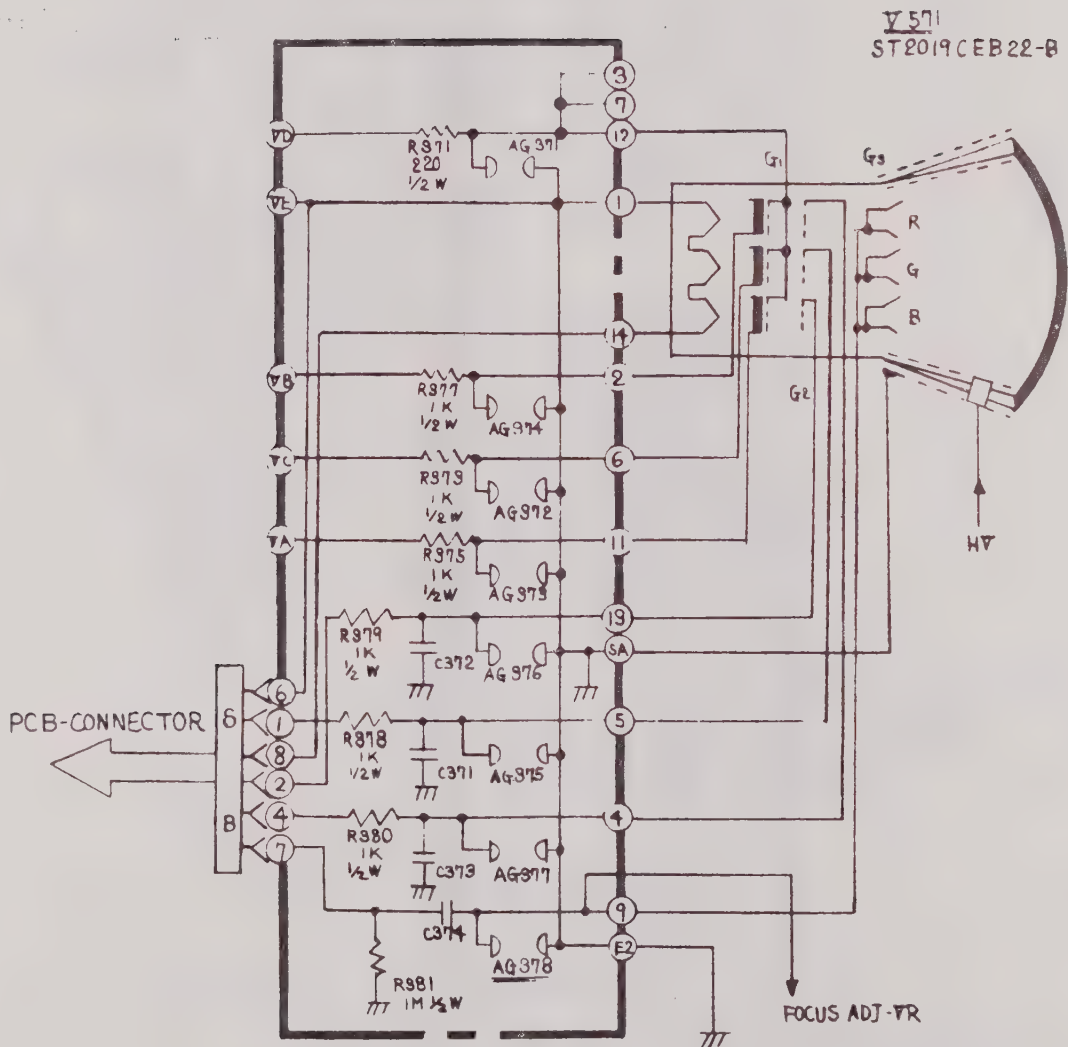
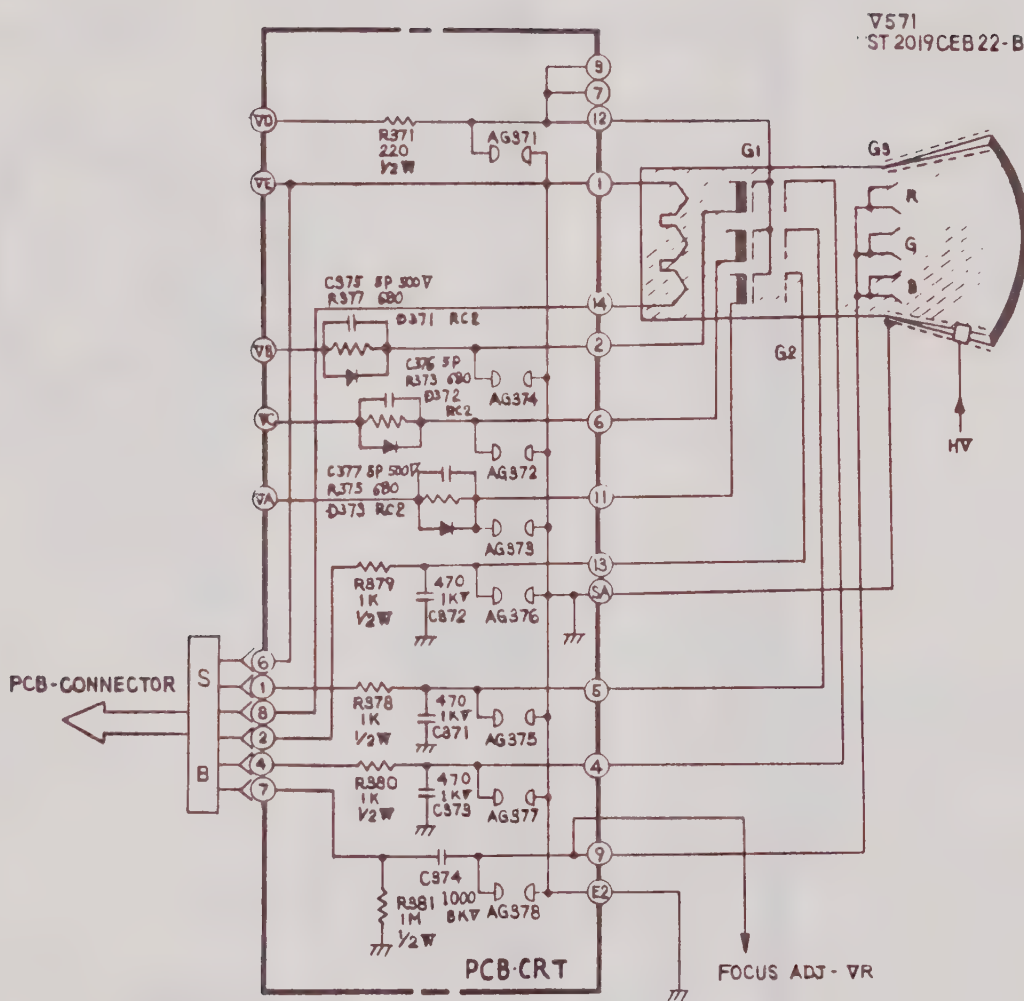


Figure 6-8. PCB-DEFL



Effective Serial Numbers 9101300 and Below

Figure 6-9. PCB-CRT
(Sheet 1 of 2)



Effective Serial Numbers 9101301 and Above

- Refer to Figure 6-1 for connector pin assignments

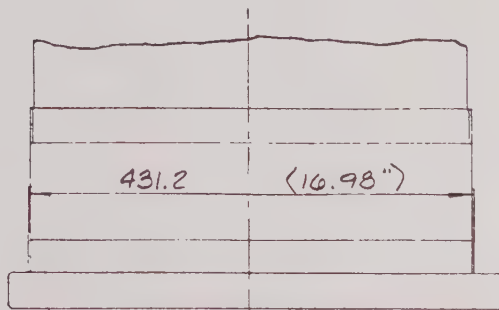
Figure 6-9. PCB-CRT
(Sheet 2 of 2)



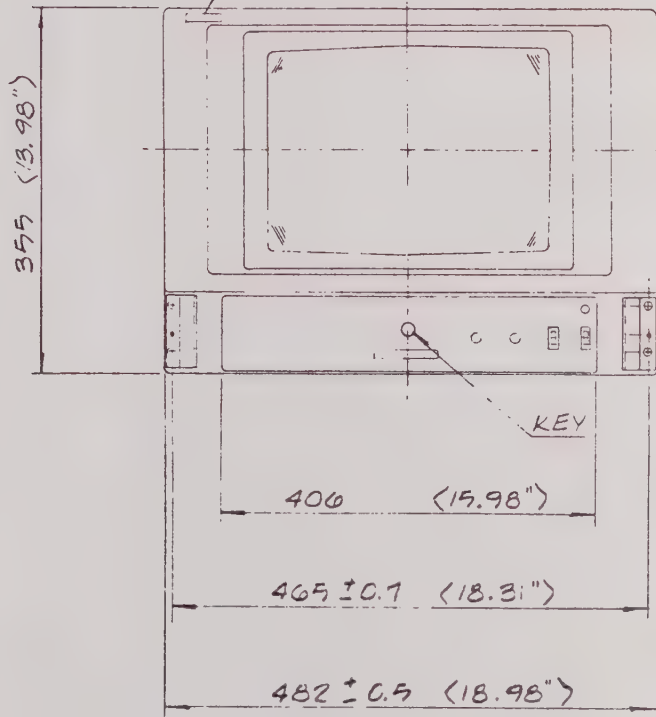


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C



B



15.8 ± 0.2 (0.2 ± 0.01)

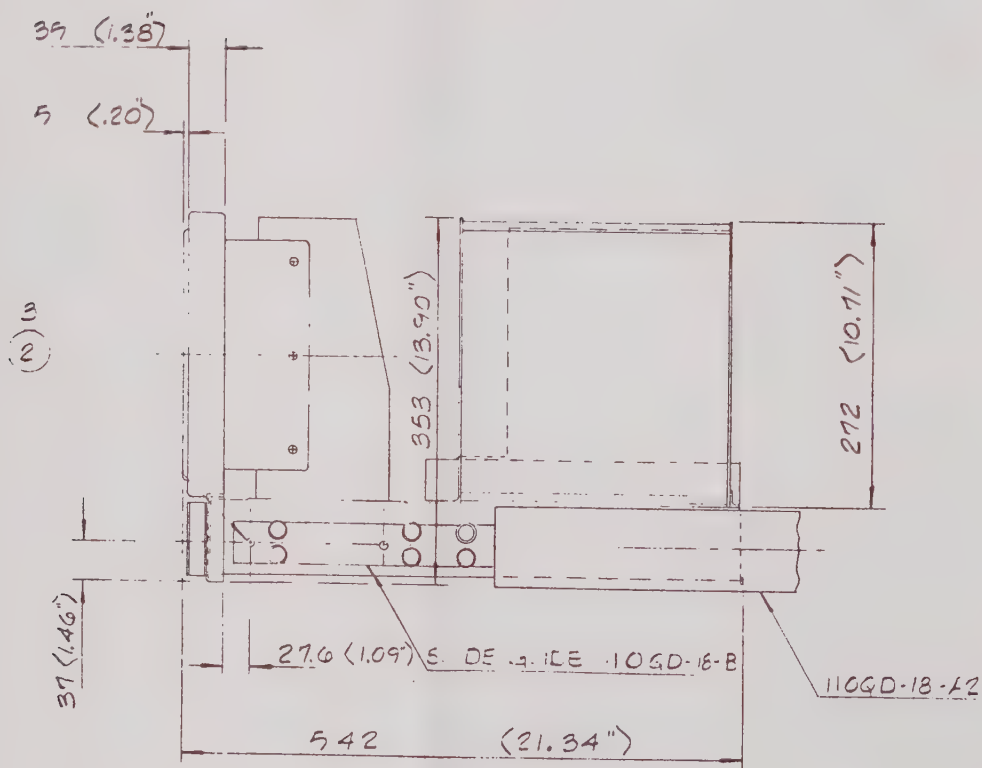
A

3

2

1

REVISIONS			
LTR	DESCRIPTION	APVD	DATE
A	RELEASE PER ECO#03995	1/22	9/8/74



8	0199992	SURE, FLT HD. X-RELESS 10-32 X 3/8	3
2	0300120	SLIDES	2
1	502874	LOGO	1
QTY REQD	PART NO.	ITEM DESCRIPTION	ITEM NO.

LIST OF MATERIALS

TOLERANCES UNLESS OTHERWISE SPECIFIED: REMOVE ALL BURRS & BREAK ALL SHARP EDGES.		DO NOT SCALE DRAWING		RAMTEK	
.XX .XXX ANG		SIGNATURES		DATE	
MATL		DWN		8-24-78	
FINISH		CHK		9/6/74	
NEXT ASSY		ENG		SIZE	
		APVD		SCALE	
				SHT 1 OF 1	
				DWG NO. 50396-1-01	
				REV A	

3

2

1

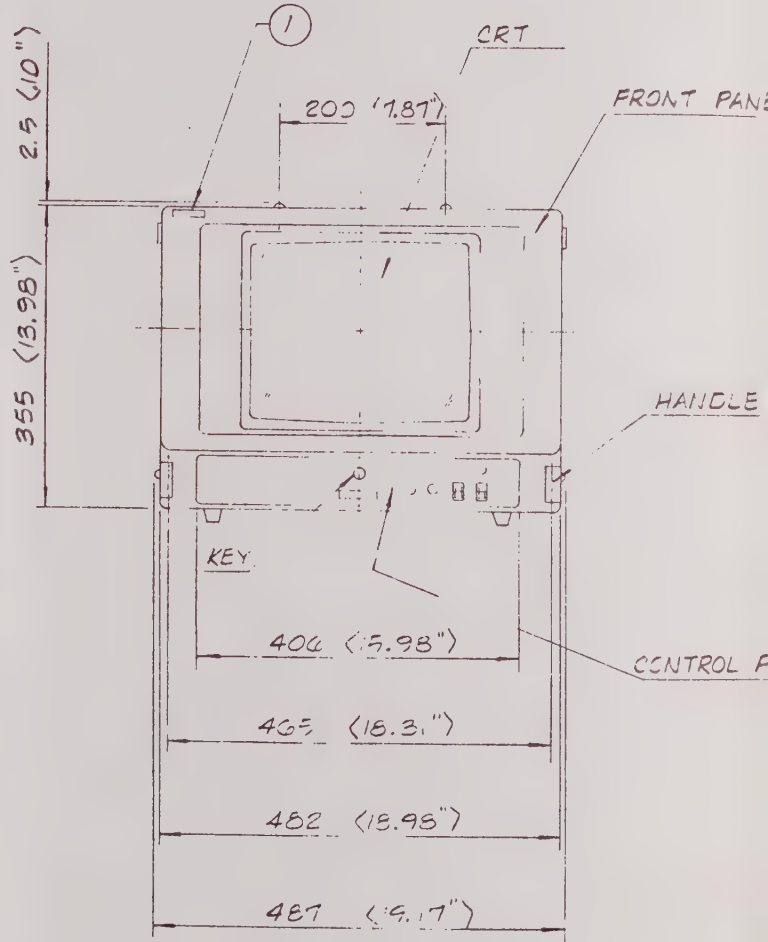
5 4

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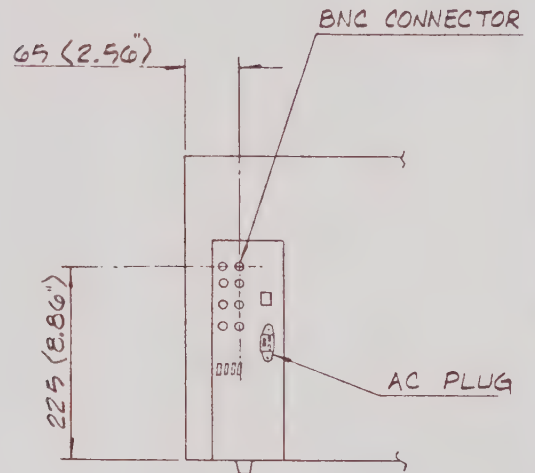
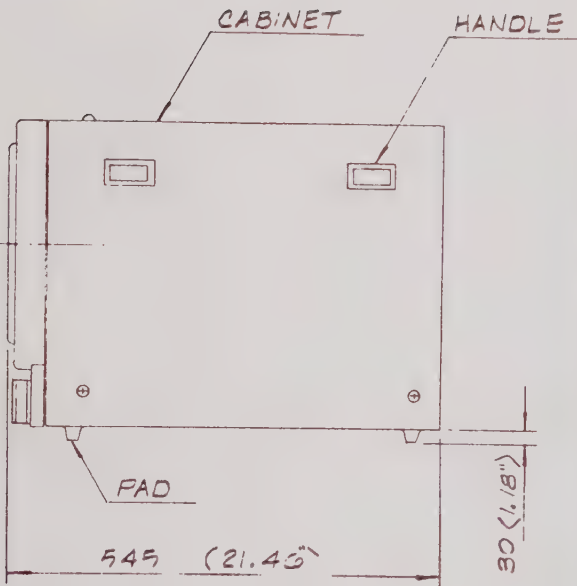
C

B

A



REVISIONS			
LTR	DESCRIPTION	APVD	DATE
A	RELEASE PER E.C.O.#0344	Mac	9/17/74

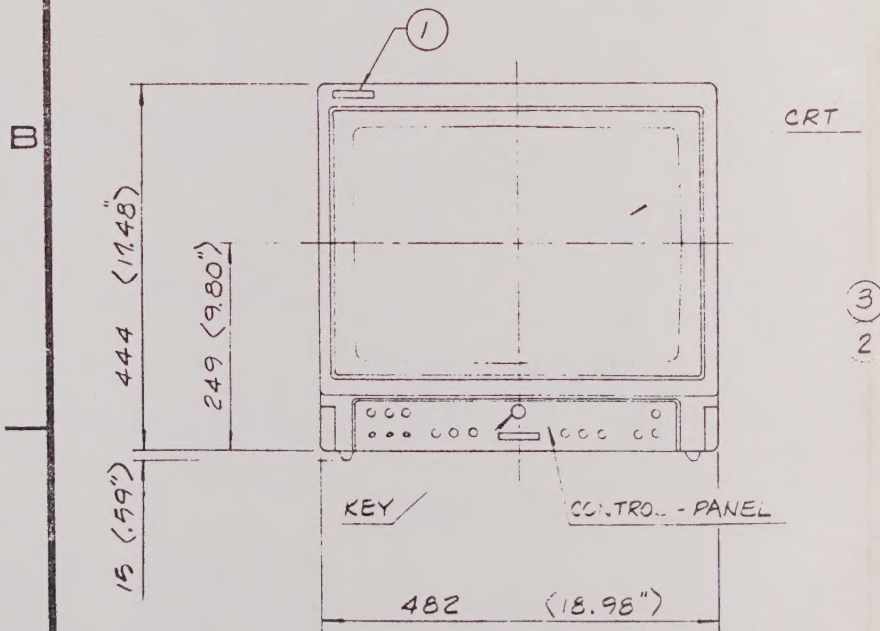
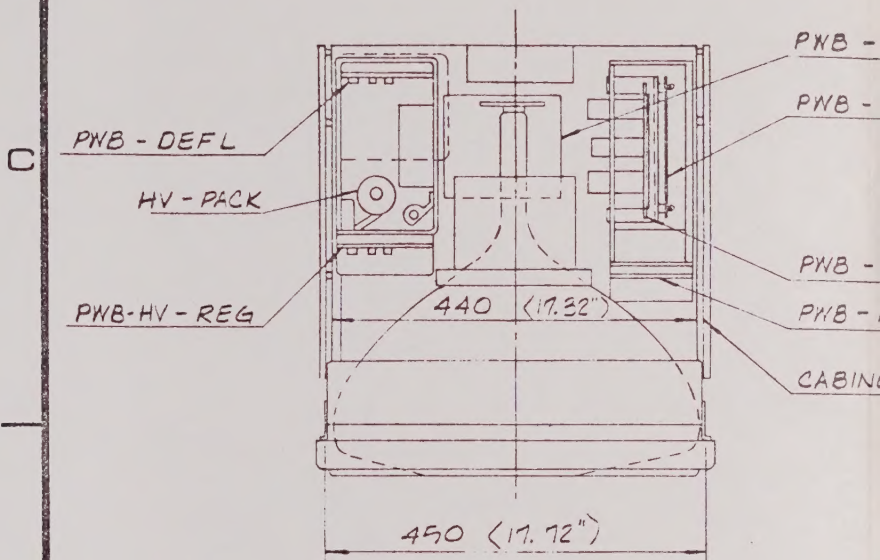


1	502874	LOGO	1
QTY REQD	PART NO	ITEM DESCRIPTION	ITEM NO.

LIST OF MATERIALS

TOLERANCES UNLESS OTHERWISE SPECIFIED: REMOVE ALL BURRS & BREAK ALL SHARP EDGES. .XX .XXX ANG		DO NOT SCALE DRAWING		RAMTEK	
SIGNATURES DWN <i>K. Kohnke</i> 8-28-78 CHK <i>Mac</i> 9/17/74 ENG APVD <i>Mac</i> 9-8-74		DATE		CHASSIS OUTLINE DWG MONITOR MODEL GM-713	
MATL _____ FINISH _____		SIZE C		SCALE 1" = 1"	
NEXT ASSY _____		DWG NO. 503967-02		REV A	

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REVISIONS			
LTR	DESCRIPTION	APVD	DATE
A	RELEASE PER ECO 0395	<i>Ar</i>	7/6/78

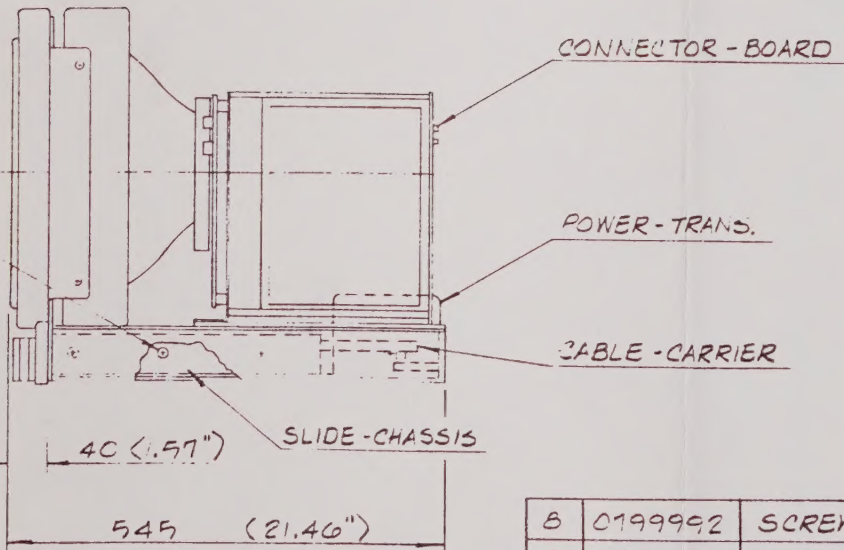
CONNECTOR

VIDEO

POWER

POWER - REG

TEST HOLDER



8	0199992	SCREW, FLT. HD. X-RECESS 10-32x3/8	3
2	0300120	SLIDES	2
1	502874	LOGO	1
QTY REQD	PART NO.	ITEM DESCRIPTION	ITEM NO.

LIST OF MATERIALS

TOLERANCES UNLESS OTHERWISE SPECIFIED: REMOVE ALL BURRS & BREAK ALL SHARP EDGES.		DO NOT SCALE DRAWING		RAMTEK	
.XX	.XXX	ANG			
MATERIAL		OWN	<i>K. F. F. F.</i>	DATE	8-28-78
FINISH		CHK	<i>Ar</i>	DATE	7/6/78
NEXT ASSY		ENG		SIZE	SCALE NTS
		APVD	<i>Ar</i>	1/2" = 1'	SHT 1 OF 1
				DWG NO.	503968
				REV	A

CHASSIS OUTLINE DWG.
MONITOR MODEL GM-719

